ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY W. H. MAW AND B. ALFRED RAWORTH.

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1918.

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OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C. 2.

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See Full Page Advt., page 81, Dec. 14.

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See Advertisement page 47, Dec. 21. 2409

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WORK of all description undertaken for Manufacturers, Patentees, &c. Also repairs and renewals. Best work, moderate charges.—ROSSER & RUSSELL, LTD., Queen's Wharf, Hammersmith.
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See half-page Advertisement page 78, Dec. 28.

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The Waterworks Committee Invite

Tenders for the Supply of an ELECTRICALLY-DRIVEN RADIAL ARM CRANE,

to be erected at their Denton Reservoirs, Denton, near Manchester.

Specification and Form of Tender can be obtained on application to the SECRETARY, Waterworks Department, Town Hall, Manchester.

Tenders, endorsed "Tender for Radial Arm Crane," and addressed to the Chairman of the Waterworks Committee, to be forwarded not later than the 2nd of February, 1918.

By Order,

THOMAS HUDSON,

Town Hall, Manchester, Town Clerk.

27th December, 1917. J 930

THE METROPOLITAN ASYLUMS BOARD invite

Tenders for Docking and

Un-docking the River Ambulance Steamer, "Geneva Cross," in accordance with Specification prepared by Mr. Thomas Cooper, M.Inst.C.E., M.I.Mech.E., Assistant Engineer to the Board. Specifications, Conditions of Contract and Forms of Tender may be obtained at the Office of the Board; Embankment, E.C. 4. Tenders, addressed as noted on the forms, must be delivered at the Office of the Board not later than Ten a.m. on Wednesday, 9th January, 1918.

By Order,

DUNCOMBE MANN,

Clerk to the Board.

31st December, 1917. J 937

APPOINTMENTS OPEN.

CHESHIRE COUNTY COUNCIL.

EDUCATION COMMITTEE.

TRAINING COURSES FOR DISABLED SAILORS AND SOLDIERS.

Wanted, an Instructor as

soon as possible for a Day-time Course at Crewe for Disabled Sailors and Soldiers in Motor Tractor Attendants' and Motor Mechanics' Work.

The Course may be followed by another similar one. Salary of Instructor, £4 per week.

Applications should be sent to H. D. STRUTHERS, Esq., Education Office, Crewe, from whom further particulars may be obtained.

RD. P. WARD,

Director of Education.

County Education Offices, Chester. J 914

CHESHIRE COUNTY COUNCIL.

EDUCATION COMMITTEE.

TRAINING COURSES FOR DISABLED SAILORS AND SOLDIERS.

Wanted, an Instructor as

soon as possible for a Day-time Course at Northwich for Disabled Sailors and Soldiers in work in the Drawing Office and Estimating Department of an Engineering Works.

The Course may be followed by another similar one. Salary of Instructor, £4 per week.

Applications should be sent to A. E. THOMAS, Esq., Education Office, Northwich, from whom further particulars may be obtained.

RD. P. WARD,

Director of Education.

County Education Offices, Chester. J 915

GUILDFORD EDUCATION COMMITTEE.

Acting for the Surrey County Council.

GUILDFORD JUNIOR TECHNICAL SCHOOL.

The Committee invite

Applications for the Appointment of a TEMPORARY ASSISTANT MASTER

to teach mainly Practical Mathematics. Duties to commence in January next. Commencing salary £160 per annum.

Applicants must be ineligible for Military Service.

Forms of application, which will be sent on receipt of a stamped addressed foolscap envelope, must be returned to the undersigned not later than Wednesday, January 16th, 1918.

F. G. SHIRLEY,

Acting Secretary.

Technical Institute, Park Street, Guildford. J 925

LOUGHBOROUGH TECHNICAL INSTITUTE.

Principal—H. SCHOFIELD, B.Sc. (Lond.).

Applications are Invited for

the post of HEAD of the ELECTRICAL ENGINEERING DEPARTMENT, at a commencing salary of £220 per annum, with £30 war bonus, and suitable increments subject to satisfactory service.

Candidates must be ineligible for military service and possess teaching and engineering works experience.

Further particulars and forms of application may be obtained from the PRINCIPAL. These must be returned to the Institute before January 19th.

W. A. BROCKINGTON, M.A.,

Director of Education. J 870

The Stafford Coal & Iron Co., LTD.,

Stoke-on-Trent, REQUIRE the SERVICES of a GENTLEMAN to act as General Manager of their collieries and blast furnaces. It is necessary for applicants to have had practical experience in mining and blast furnaces, and to be capable of dealing with the commercial side of the business.—Applications, stating age, qualifications, experience and salary required, to be sent to

STAFFORD COAL & IRON CO., LTD.,

Care of SUTHERLAND ESTATES OFFICE,

35, Parliament Street,

London, S.W. 1. J 924

Works Superintendent

WANTED, for progressive controlled works employing 250 hands. Must be conversant with latest methods of works organization and production, especially in machine and large drop stamping departments. No commercial duties.—Apply, in confidence, with full particulars of age, experience and salary required,

WORKS SUPERINTENDENT,

care of JOSHUA WORSLEY & SONS,

Chartered Accountants, J 876

George Street, Sheffield.

MACHINE TOOLS.

Wanted for London, Smart

MAN (exempt from Military service), experienced in the purchase and sale of Modern Machine Tools. Good opportunity for a real live man.—Address, J 971, Offices of ENGINEERING.

Assistant Manager.—Experienced MARINE ENGINEER WANTED

as Assistant Outside Manager in large repair works. Knowledge of reciprocating and turbine machinery necessary. Accustomed to handling large number of men. Age not to exceed 40. Good salary and prospects to suitable man.—Address, J 871, Offices of ENGINEERING.

Assistant Ship Manager Re-

QUIRED by large repairing firm. Applicant must have experience of Admiralty and Mercantile repairs and be accustomed to the control and efficient working of large numbers of men. Age between 30 and 35 years. Salary and prospects progressive with ability.—Address, J 872, Offices of ENGINEERING.

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Director of Aluminium Foundry. A man is wanted of good education, age 26 to 30, with engineering knowledge and some foundry experience, to take up this post in a prominent Foundry in the Midlands. It is a permanent appointment, offering good facilities for experience and advancement to an intelligent man. One whose military service is completed will be preferred. No one employed on Government work will be engaged.—Write, giving full details of education, experience, references, and stating salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and A 4293. J 804

Meter Superintendent, Per-

manent Staff appointment; Corporation, Midlands; £170, including War Bonus. Applications giving full particulars of qualifications.—Address, J 883, Offices of ENGINEERING.

Wanted (Male or Female),

CHEMIST, preferably accustomed to metal analysis, for Midland Engineering Works. A live inorganic chemistry student, keen and willing to learn and with suitable previous training, will be considered. No person already engaged on Government work will be appointed.—Apply, giving full particulars of training and experience, age, and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4530. J 899

Head of Contracts and Pur-

chase Department REQUIRED by large engineering firm on aircraft work. Must be thoroughly capable and experienced man with knowledge of engineering work and materials. Apply by letter, stating age, nationality, experience, references and salary required. Only those resident in London and not engaged on Government work need apply.—Address, J 904, Offices of ENGINEERING.

Estimator Required

immediately by important firm in South Midlands; preferably draughtsman with not less than four years' shop training and sound knowledge of machining methods. No one already on Government work will be engaged.—Apply, giving particulars of experience, age and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and J 953.

Representative Required by

Steel Manufacturers (new process). Splendid prospects for a man of ability and good presence, capable of demonstrating their product. Applicants must be proved business getters, with knowledge of engineering and tool making preferred, and should be ineligible for Military service. Salary £4 per week, plus commission and expenses.—Write, giving full particulars to "M," care of GONNOX & GOTCH, Ltd., 19, St. Bride Street, E.C. 4. J 922

Inspector Wanted by Con-

trolled Firm of Midland Machine Tool Makers. Work consists of inspecting detail work of machines, and running machines before despatch. Only those accustomed to machine tools need apply. State age, experience, and salary required. No one already employed on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and J 931.

Inspector Wanted, to Keep

Oversight on and be responsible for all detail work from the machine shop of a controlled establishment, medium size work. To a good mechanic, possessed of tact and character, a good position is assured. No one employed on Government work will be engaged.—Apply, stating age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and J 758.

THE SECRETARY OF STATE FOR INDIAIN COUNCIL will, in 1918,

Appoint Three Natives OF INDIA,

if found qualified, as ASSISTANT ENGINEERS in the Indian Public Works and State Railway Departments.

Candidates must be eligible under Clause 5 of the Regulations and, save as provided in Clause 3 of the Regulations, must be not less than 21 and not more than 24 years of age on 1st July, 1918. They must either have obtained one of the certain recognised University degrees or other distinctions in Engineering, or have passed the Associate Membership Examination of the Institution of Civil Engineers.

Applications must reach the India Office by 31st March, 1918. Printed forms, together with information regarding the conditions of appointment, may be obtained from the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W.1.

India Office, London.

5th December, 1917. J 801

Cost Clerk Wanted, for

urgent Government work (Yorkshire district). Must be thoroughly experienced in analysis of weights and accounts, also on-cost charges, in connection with foundry and machine shops. Progressive position to steady, energetic man, capable of assisting the organising and working up of up-to-date cost systems. State age, experience and salary required. No person already employed on Government work will be engaged. Applicants must apply to their nearest EMPLOYMENT EXCHANGE, mentioning ENGINEERING and J 730.

Head Storekeeper Wanted,

for Aircraft Works; previous experience preferable. State age, experience and salary required. No one employed on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and J 947.

Engineering Teacher

(whole-time) WANTED at once. Salary £200 to £250.—For particulars, apply to J. HAGLES, A.R.C.Sc., Principal, Technical College, Doncaster. J 883

Civil Engineer or Good Fore-

MAN BUILDER, not subject to military service, WANTED, for Lagos, Nigeria, to superintend development of shipping depot. First-class passage, free quarters and salary corresponding to experience.—Reply, with full particulars, age, experience, references and salary required, to G. C., care of STREET'S, 30, Cornhill, London, E.C. 3. J 908

Wanted, an Engineering

ASSISTANT for large Waterworks Co. in South of England. Previous experience essential. Must be ineligible for Military Service, competent to make Surveys, take Levels, prepare Plans and Specifications and generally assist in the routine duties of a Waterworks Engineer's Office.

Applications, stating age, qualifications and experience, accompanied by copies of not more than three recent testimonials, to be addressed to J 906, Offices of ENGINEERING.

Engineer Required, Capable

of installing automatic machinery in connection with glassworks development. Knowledge of up-to-date gas producer plant and furnaces would be a recommendation. To a suitable man the position offers good prospects. Apply, giving full particulars, experience and salary required.—Address, J 919, Offices of ENGINEERING.

Furnaces.—Engineer Re-

QUIRED, experienced in the designing and construction of solid fuel and producer furnaces for all heat-treating propositions. Excellent position and prospects for ready good man.—Write fully, Address, J 909, Offices of ENGINEERING.

Chief Draughtsman Wanted,

for Controlled Establishment in West Riding of Yorkshire, manufacturing Petrol-driven Commercial Motor Vehicles.

Only those having previous first-class experience need apply, and no person already on Government work will be engaged.

Apply, in first instance, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4305, and stating particulars of experience, age and salary expected. J 900

Draughtsmen, with Experi-

ence in coke oven plant, coal-handling machinery, and chemical or tar plants, WANTED Immediately.—Apply, stating experience, age, and salary required, to KOPPERS' COKE OVEN AND BYE PRODUCT CO., 301, Glossop Road, Sheffield. No one already employed on Government work will be engaged. J 348

Leading Firm of Heating

Engineers in the Provinces, REQUIRE DRAUGHTSMAN for Government work. No person already on Government work will be engaged.—Apply, stating age, qualifications, and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and J 923.

Draughtsman, with General

Engineering experience, REQUIRED for controlled establishment in Scotland. Permanent situation to suitable applicant. No person already on Government work will be engaged.—Apply, stating age, experience and salary expected, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4251. J 925

Mechanical Draughtsmen and

DETAILERS REQUIRED for work in War Office Department, London. Experience in steam turbine and factory lay-out preferred. No one already on Government work will be engaged.—Apply, stating wages required and full details of experience, to your nearest EMPLOYMENT EXCHANGE, quoting this Journal and A 4377. J 934

Mechanical Draughtsmen Re-

QUIRED for aircraft work in Government establishment 35 miles from London. Previous aircraft experience not essential.—Address, giving wages required, particulars of qualifications and experience to J 944, Offices of ENGINEERING.

Chief Draughtsman and two

ASSISTANT DRAUGHTSMEN required. Engineering Shop experience necessary for Chief and desirable for Assistants. Apply by letter with copies of testimonials, stating experience and wages required. No one on Government work will be engaged.—Apply to your nearest Employment Exchange, mentioning this Journal and No. A 4262. J 955

Draughtsman.—Vacancy for

DRAUGHTSMAN, experienced in Reinforced Concrete work, occurs with a Shipbuilding Company in their London office. Excellent prospects for a capable man. No person already engaged on Government work or living over ten miles away need apply.—Application and copies of testimonials to J 957, Offices of ENGINEERING.

Draughtsman Wanted, for

Designing and Drawing Offices of a large shipbuilding works on West Coast. No person already on Government work will be engaged.—Applicants should state salary and experience to their nearest EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 4265. J 820

Draughtsmen Wanted for

Power Station work.—Apply by letter, stating particulars of experience, age, and wages required, to YORKSHIRE ELECTRIC POWER COMPANY, Wellington Road, Dewsbury. J 966

Draughtsman Wanted for

Designing and Drawing Office of a large provision works in South Essex. Must have good mechanical experience.—Apply, stating age, experience, including works experience and salary required, to J 902, Offices of ENGINEERING.

Wanted, Experienced

DRAUGHTSMAN to draw out mechanical details of Dynamos and Motors to Electrical Designer's particulars, and capable of calculating the strengths of mechanical parts to suit. No application will be considered unless age, experience, and salary required is stated. No person already on Government work will be engaged.—Reply to nearest EMPLOYMENT EXCHANGE, mentioning this Journal and J 912.

Wanted, Two Draughtsmen,

accustomed design machine tools. Apply stating age, salary required, and experience. No one employed on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and J 918.

Wanted, Experienced and

Capable Jig and Tool DRAUGHTSMAN, preferably with experience of motor vehicle manufacture. London district. No person already on Government work will be engaged.—Apply, stating age, salary, and full particulars of experience, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 3929. J 897

Wanted, Jig and Tool

DRAUGHTSMAN, for large firm of electrical engineers in the Midlands. Experienced designer of press tools, formers and general tools, jigs, &c., for electrical motors and generators.—Apply, stating age, experience and salary required, mentioning this Journal and No. A 4280. Nobody engaged on Government work will be accepted. J 814

Wanted, First-class De-

SIGNERS and DRAUGHTSMEN for Aeroplane work in London. University men preferred. No one already employed on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and J 695.

Draughtsman Required, used

to designing and carrying out schemes for Rolling Mill Plants and general steel works equipments. No person already on Government work will be engaged.—Apply, stating experience, age and salary required to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and A 4312. J 881

Wanted, Sheerness District,

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ENGINEERING.

THE ESCAPE OF EXHAUST GAS IN TWO-STROKE CYCLE ENGINES.

By Guy B. Petter, A.R.C.S.

In a two-stroke cycle engine it is necessary to know the time required for the exhaust pressure to fall from its initial value to the atmospheric. Engines of the type referred to have inlet and exhaust ports in the cylinder walls which are uncovered by the piston towards the end of its outward stroke. The exhaust ports are given a "lead" so that the exhaust may get away by the time that the air ports open

The velocity of escape of exhaust gas through the exhaust ports is affected with many uncertainties and especially with the contraction of the gas by cooling. As, however, we wish to establish a formula for purposes of comparison only we assume that the fall of pressure is due entirely to the escape of gas through the exhaust ports at constant velocity.

Let v = the constant velocity in inches per second.
p = the pressure (absolute) in pounds per square inch at the instant t in seconds reckoned from the moment of exhaust opening.
V = the capacity in cubic inches of the cylinder and cylinder head above the piston when the exhaust ports begin to open.
A = the area, in square inches, of the exhaust ports open at the instant t.
b = the total width of the exhaust ports in inches.
m = the engine speed in degrees per second.
a = the crank throw.
c = the connecting-rod length.
e = the line joining the crankshaft centre to the gudgeon pin; all these measurements to be taken in inches as before.

Values with the suffix o are for initial conditions when the exhaust ports begin to open, and values with the suffix f are for final conditions when atmospheric pressure is reached. It will be noted that p_f is atmospheric pressure in absolute units.

The total quantity of gas escaping is

$$\frac{p_0 - p_f}{p_f} \text{V}.$$

The quantity of gas escaping in a small interval Δt at the instant t is

$$\frac{p}{p_f} v \text{A} \Delta t$$

and

$$\frac{p_0 - p_f}{p_f} \text{V} = \int_{t_0}^{t_f} \frac{p}{p_f} v \text{A} \, dt \quad . \quad . \quad (1)$$

Assuming from the evidence of the indicator card that the fall of pressure is directly proportional to the time, we write

$$p = p_0 - \frac{(p_0 - p_f)\, t}{t_f} \quad . \quad . \quad . \quad (2)$$

Also, we may write with sufficient accuracy

$$\text{A} = \frac{\text{A}_f}{t_f} t \quad . \quad . \quad . \quad (3)$$

Then we shall have

$$\frac{p_0 - p_f}{p_f} \text{V} = \int_{t_0}^{t} \frac{p_0 t_f - (p_0 - p_f)\, t}{p_f\, t_f} v \frac{\text{A}_f}{t_f} t \, . \, dt \quad (4)$$

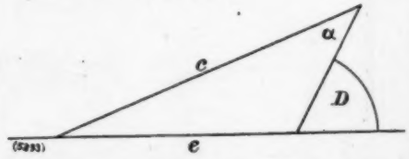
Integrating and applying the limits we have

$$\frac{p_0 - p_f}{p_f} \text{V} = v \text{A}_f \left[\frac{p_0}{p_f\, t_f} \cdot \frac{t_f^2}{2} - \frac{p_0 - p_f}{p_f\, t_f} \cdot \frac{t_f^3}{3} \right] \quad (5)$$

or

$$\text{V} = \frac{v \text{A}_f\, t_f\, (p_0 + 2\, p_f)}{6\, (p_0 - p_f)}.$$

Consider the triangle in the subjoined diagram, formed by the crank a, the connecting rod c and the line e from the crank-shaft centre to the gudgeon-pin. Neglecting the obliquity of the connecting rod, the depth of the exhaust port opening at the instant t is a (cos D − cos D_0) where D is the angle of the crank before dead centre position



(5233)

at the instant t, and D_0 is this angle at the instant of exhaust port opening.

Then

$$\text{D}_0 - \text{D} = m\, t \text{ or } \text{D} = \text{D}_0 - m\, t \quad . \quad . \quad (6)$$

And

$$\text{A}_f = a\, b \left\{ \cos (\text{D}_0 - m t_f) - \cos \text{D}_0 \right\} \quad . \quad (7)$$

Therefore

$$\text{V} = v\, a\, b\, t_f \frac{p_0 + 2\, p_f}{6\, (p_0 - p_f)} \left\{ \cos (\text{D}_0 - m\, t_f) - \cos \text{D}_0 \right\} \quad (8)$$

From (8) we can compute v if t_f is known or t_f if v is known. The solution for t_f is best found graphically from the intersection of the curves

$$y = \frac{6\, (p_0 - p_f)\, \text{V}}{v\, a\, b\, t_f\, (p_0 + 2\, p_f)} \quad . \quad . \quad . \quad (9)$$

and

$$y = \cos (\text{D}_0 - m\, t_f) - \cos \text{D}_0 \quad . \quad . \quad (10)$$

It is not to be supposed that these results will be physically correct, but they will serve for purposes of comparison. A mean value of v under ordinary working conditions can be obtained with the indicator card of any well designed engine taking t_f from the card and v from (8). For the Petter crude oil engine it is found to be in the region of 1,650 ft. per second. With this value of v it is easy to determine from equation (8) suitable values for the width and lead of the exhaust ports. The relation

$$e^2 = c^2 - a^2 - 2\, a\, e \cos \text{D}.$$

enables the position of the piston to be found for any crank angle D.

TESTING MACHINES FOR AEROPLANE MANUFACTURE.

At the present time there is but little need to urge the importance of aircraft in warfare. Their value for reconnaissance, artillery observation, aerial fighting, and bombing has been so amply demonstrated that few will dispute the statement that of two opposing armies that which had a marked superiority in aircraft would be successful even if somewhat weaker in other respects. In the views of many competent authorities the present slow and costly process of trench warfare would be speedily terminated if aeroplanes could be supplied to the Allied armies in sufficient numbers to clear the air of enemy machines and thus deprive him of the power of observation which is so essential to successful artillery work. The continual bombing of enemy lines of communication and munitions manufacturing centres would also contribute largely to the achievement of the object we have in view. It is thus evident that an enormous number of machines are required, and when it is borne in mind that the average life of an aeroplane under war conditions is rather less than two months, the question of production assumes an almost appalling magnitude. Fortunately, the manufacturing resources of the allied nations are greatly superior to those of the enemy, so that we may approach the problem with confidence, but at the same time it is clear that the best possible use must be made of the labour, materials and plant available.

Another point which must not be overlooked is that to achieve complete success it is not only necessary to produce aircraft in enormous numbers; each class of machine must be of higher efficiency than those employed by the enemy for similar work. This depends, among other things, upon the utilisation of the materials of construction to the best advantage, so that the necessary strength can be obtained with the least possible weight. Although a liberal factor of safety is allowed for the stresses on an aeroplane in normal flight, it is probable that the stresses produced by some of the daring manœuvres executed by our fighting pilots approach closely to the breaking point of the materials used. Certainly the factor of safety cannot be large, so that to avoid failure it is necessary frequently to test the strength of the materials used and to reject any which fall below the standard of strength set by the designer.

A number of testing machines specially designed by Messrs. W. and T. Avery, Limited, of Soho Foundry, Birmingham, for use in connection with aeroplane manufacture, are illustrated on pages 2, 3 and 12. The first of these, Fig. 1, on page 2, is used for balancing the connecting rods of aeroplane engines. To ensure smooth running of the high

TESTING MACHINES FOR USE IN AEROPLANE MANUFACTURE.

CONSTRUCTED BY MESSRS. W. AND T. AVERY, LIMITED, ENGINEERS, BIRMINGHAM.

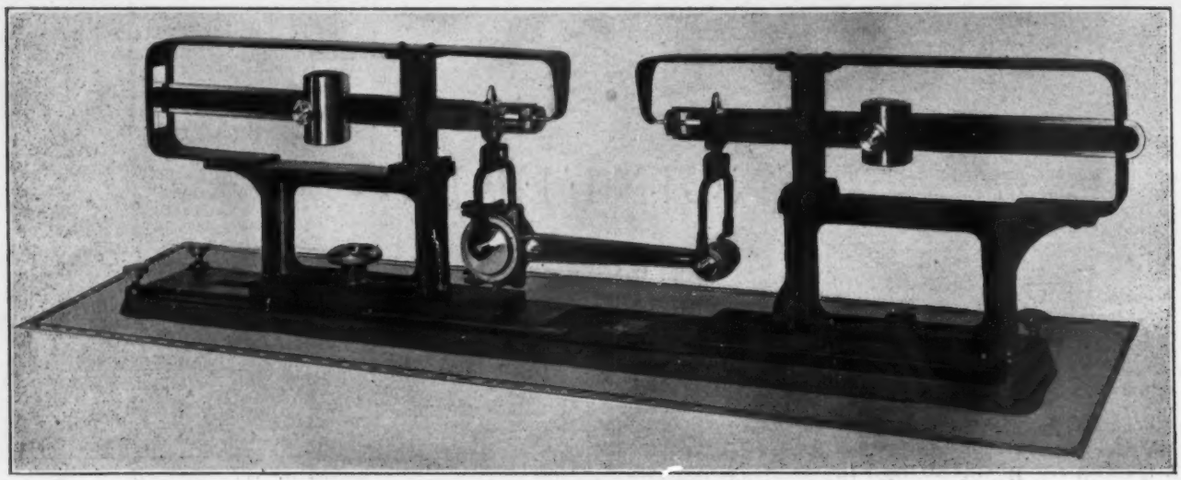


FIG. 1. CONNECTING-ROD BALANCER.

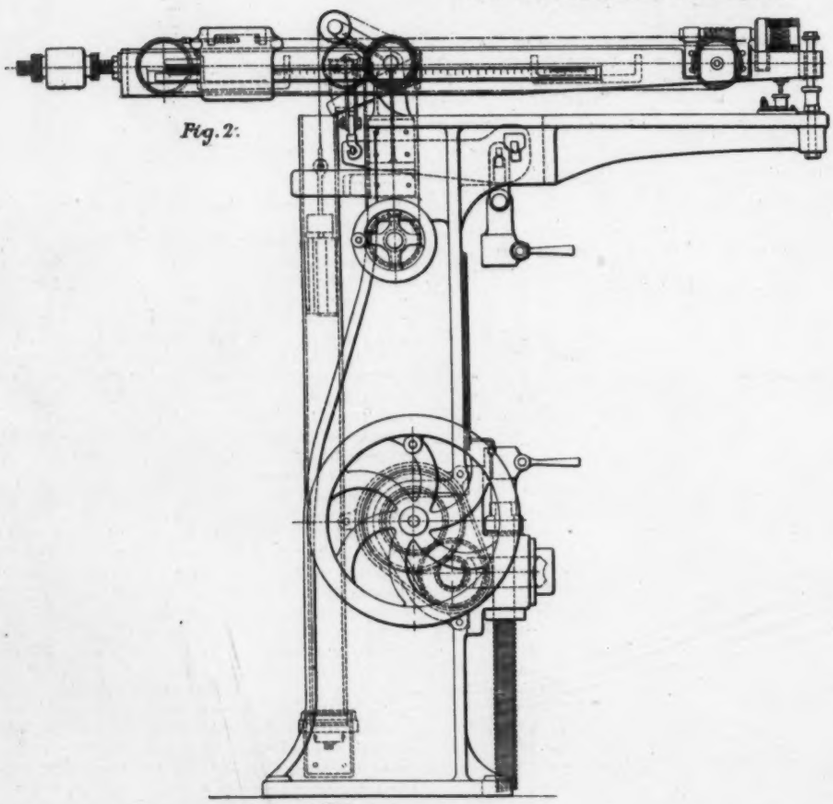


Fig. 2.

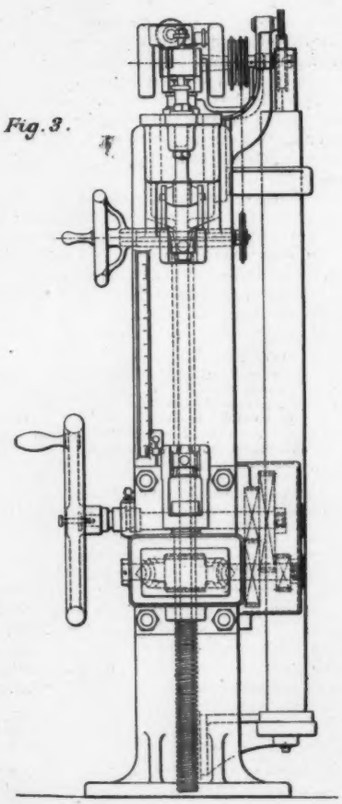


Fig. 3.

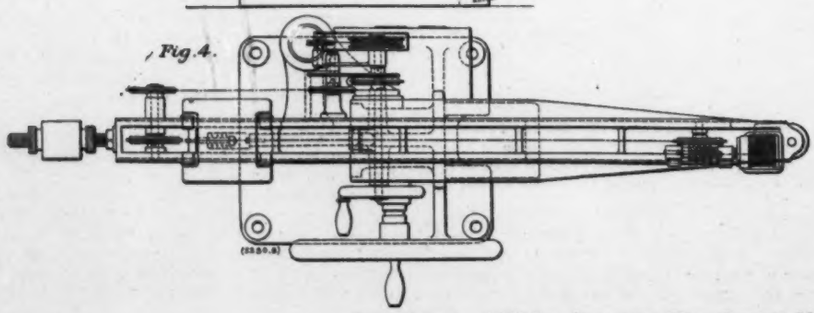


Fig. 4.

FIGS. 2 TO 4. 6,000-LB. AUTOPOISE WIRE TESTING MACHINE.

TESTING MACHINES FOR USE IN AEROPLANE MANUFACTURE.

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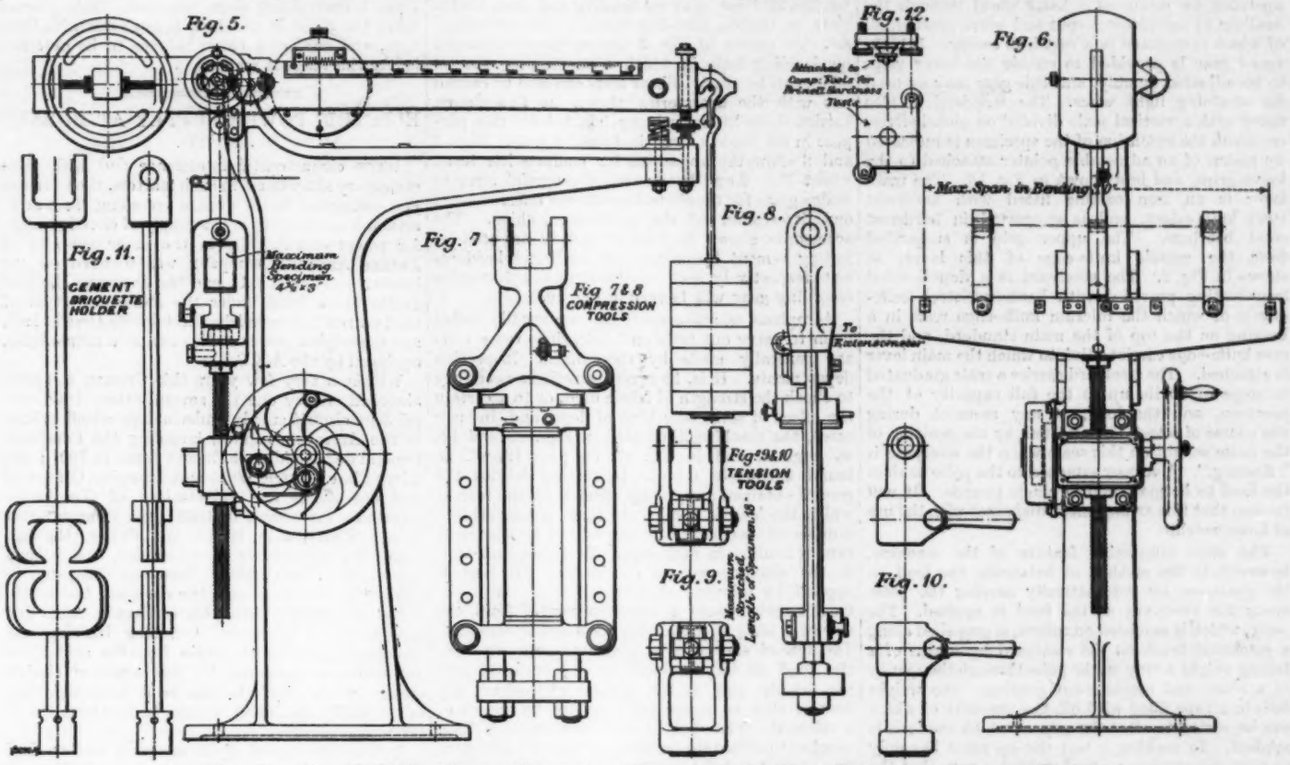
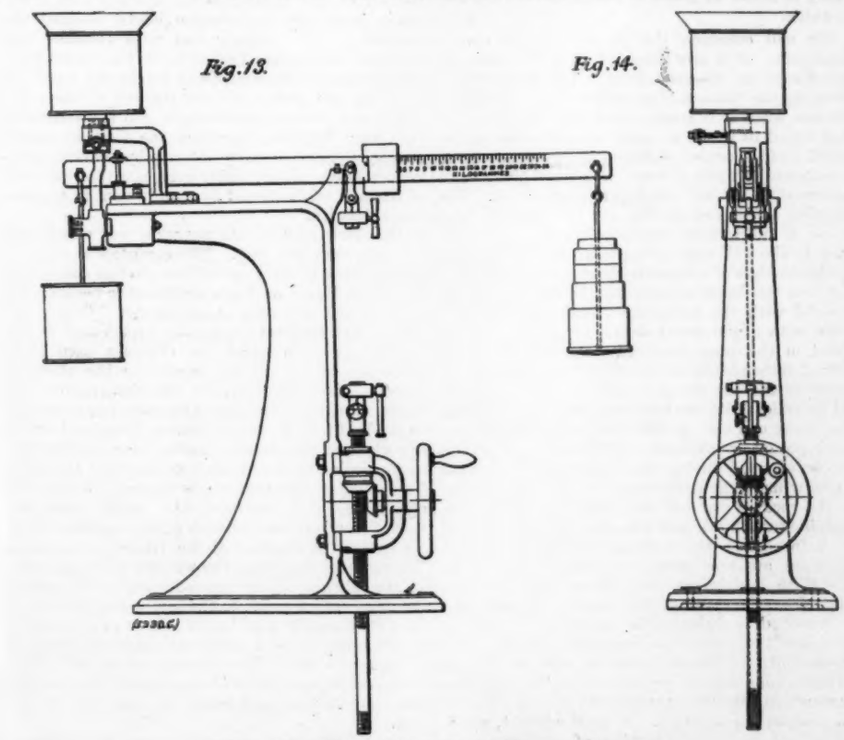


FIGS. 5 TO 12. 10,000-LB. TESTING MACHINE FOR TENSILE, COMPRESSION, BENDING OR SHEARING TESTS.



FIGS. 13 AND 14. MACHINE FOR TESTING FABRICS.

speed engines used on aircraft, special attention must be given to the balance of the moving parts. The connecting rods of an engine must all be of equal weight, and moreover the distribution of the weight must be the same in all cases. This is not easily secured, even in rods which are machined all over, owing to errors in machining and variations in the density of the material. With the machine illustrated, however, it is easy to determine whether or not the correct balance has been obtained and, if not, to make the necessary adjustments. As will be seen, the machine consists of a pair of steelyards, each carried on a cast-iron frame which is mounted on a cast-iron baseplate fitted with levelling screws. One of the frames, it will be noticed, can be adjusted in a longitudinal direction to accommodate rods of different lengths. In using the machine a standard rod, which should be left a little lighter than those to be adjusted, is first suspended in a horizontal position from the inner ends of the steelyards, as shown in the illustration, and the counterpoises adjusted until a perfect balance is obtained. This rod is then removed and replaced by a rod to be balanced. The balance of both steelyards is then restored by removing material from the rod, the total weight of which, as well as the weight distribution, will then be the same as the standard rod. It is, of course, essential that the rods should all be suspended from the same centres, and for this reason a short mandril, having knife edges at its centre, is slipped into each end of the rod. The knife edges rest in stirrups suspended from the ends of the steelyards, as will be clear from an inspection of Fig. 1. If desired, the steelyards can be graduated in ounces and provided with small poise weights, which can be set to predetermined tolerances. Such tolerances are often used in specifications, and, in any case, the auxiliary poise weights form a convenient method of determining the exact amount of excess material which has to be removed to secure the correct balance.

It is very often necessary to check the tensile strength of wires of both stream-line and circular sections, as well as stranded cables, sheet steel and other metals, turnbuckles, &c., since these articles figure so largely in the construction of aircraft. The drawings of a very convenient machine for this class of work are reproduced in Figs. 2, 3 and 4, on page 2, while Fig. 15, on page 12, gives a good idea of its general appearance. The machine will take specimens up to $\frac{1}{2}$ in. in diameter or $\frac{1}{4}$ in. square, or flat specimens up to $\frac{7}{8}$ in. wide by $\frac{1}{4}$ in. thick. The specimens may be of any length up to 12 in. between the grips, and the maximum load that can be applied

is 6,000 lb. It will be seen that the machine is of the compound lever type, the levers being carried on a substantial cast-iron standard, which also supports the straining gear. The latter comprises a screw operated by means of a hand wheel through the medium of machine-cut spur and worm gearing, all of which is enclosed in a cast-iron casing. A high-speed gear is provided to enable the lower grips to be adjusted quickly, and this gear may be used for straining light wires. The standard is also fitted with a vertical scale divided on nickel silver, on which the extension of the specimen is indicated by means of an adjustable pointer attached to the lower grips, and best shown in Fig. 15. The main lever is an iron casting fitted with hardened steel knife-edges, and is supported in hardened steel bearings. The upper grip is suspended from the middle knife-edge of this lever, as shown in Fig. 2. The steelyard is a double-sided iron casting provided with hardened steel knife-edges, of which the fulcrum knife-edge rests in a bearing on the top of the main standard, and the rear knife-edge carries a link to which the main lever is attached. The steelyard carries a scale graduated in steps of 20 lb. up to the full capacity of the machine, and the load, at any moment during the course of a test, is indicated by the position of the poise weight on this scale when the steelyard is "floating." A vernier attached to the poise enables the load to be measured in single pounds. It will be seen that this arrangement dispenses with the use of loose weights.

The most interesting feature of the machine, however, is the method of balancing the load on the specimen by automatically moving the poise along the steelyard as the load is applied. The poise, which is mounted on rollers, is propelled along a machined track on the steelyard by means of a falling weight acting on the poise through the agency of a chain and machine-cut gearing. The weight falls in a tube filled with oil, the viscosity of which can be varied to alter the rate at which the load is applied. In making a test the operator has only to turn the straining wheel at such a rate that the steelyard is kept "floating." When the steelyard drops, owing to the fracture of the specimen, an electric circuit is completed, and this energises a solenoid and applies a brake to a drum, which is driven by worm gearing, and in this way the movement of the poise is instantly arrested. Its position then gives an accurate record of the breaking load since there is no possibility of the movement of the poise continuing after fracture has taken place. There is therefore no need to watch the movement of the poise in tests which are only required to determine the breaking load. The small hand wheel near the top of the main standard, and visible in all the illustrations, is for the purpose of returning the poise to the zero position at the completion of a test. It will be seen that the automatic movement of the poise at a constant rate enables any number of tests to be carried out under uniform conditions, which is important in that the strength of some materials is considerably affected by the rate of loading. Three sets of wedges are provided with this machine to take specimens of the dimensions stated above, and, if desired, a pair of clamp holders can be supplied to take thin strips up to 1 in. wide. In all cases the wedges are opened and closed by the movement of a single lever, which leaves one hand free to insert the specimens.

Another machine for similar work, but with a rather wider scope, is illustrated in Figs. 5 to 12, on page 3, and also in Fig. 16, on page 12. This machine has a capacity of 10,000 lb., and will take both flat and round specimens up to 18 in. in length when stretched. It is of the single-lever type, and the steelyard is graduated to 1,000 lb. on a scale which can be read to 1 lb. by means of a vernier attached to the poise. Additional loading, up to the full capacity of the machine, is obtained by means of loose weights, and, in favour of this system, it may be pointed out that tests requiring small loads, say up to 100 lb., can be carried out with as great a degree of accuracy as those using the full capacity of the machine. This machine is not provided with automatic means for moving the poise, so that the operator must use both the hand wheels shown in Figs. 5 and 16 when making a test, the lower one for straining the specimen and the upper one for moving the poise to balance the load. In addition to ordinary tensile tests accessories can be provided for making bending and compression tests on timber, shearing tests on bolts and pins, &c. As shown in Fig. 6 the machine is arranged for bending tests in which a maximum span of 36 in. can be used. Shear tests can also be carried out with the accessories shown in this figure, hardened steel brushes being inserted for this purpose in the holders used in bending tests. Figs. 7 and 8 show the apparatus for compression tests, whilst Figs. 9 and 10 illustrate the special form of wedge grips for tensile test specimens referred to in our description of the previous machine. The accessories shown in Figs. 11 and 12 are used for testing cement briquettes and for Brinell hardness tests respectively, and a simple form of autographic recording gear will be seen in Fig. 16.

Aeroplane manufacturers are not usually called upon to carry out tests on fabric, since these tests are generally made by Government Inspection departments. It is, however, sometimes necessary to check the strength of fabric used, or to ascertain the effect of some new kind of dope, and, in such cases, the machine illustrated in Figs. 13 and 14, on page 3, and in Fig. 17, on page 12, will be found extremely useful. In testing fabrics the results obtained are greatly affected by the rate at which the load is applied, so that in comparing a number of specimens it is essential to use the same rate of loading in each case. To accomplish this, in the machine we are considering, the load is applied by allowing shot to fall from an upper fixed reservoir into a vessel suspended from the end of a lever to which the specimen is attached. The flow of shot can be regulated so as to vary the load on the specimen by a definite amount per minute, and, at the moment of fracture, the flow of shot is immediately cut off by means of a solenoid. The shot in the lower vessel is then weighed to obtain the breaking load on the specimen. The capacity of the machine illustrated is 500 lb., which is ample to test a standard specimen 5 cm. in width.

We will conclude the present article with a description of a new form of propeller balancer introduced by Messrs. Avery. The necessity for checking the balance of propellers very carefully is obvious when it is remembered that, owing to the high speed of rotation, quite a small error in the position of the centre of gravity will produce a large unbalanced centrifugal force, which will give rise to unpleasant, if not dangerous, vibrations. The machine illustrated in Fig. 18, on page 12, comprises a substantial cast-iron bracket, which is fixed to the wall and carries bearings in which rest the knife-edges of a separate rocking beam. Projecting from this beam is a spindle, the centre of which is axial with the knife-edges, and the spindle is fitted with a gun-metal sleeve which fits the hole bored in the propeller boss. The sleeve can be turned on the spindle so that the friction between the propeller and the sleeve is not affected by turning the propeller to try the balance in different positions. The sleeve can also be locked when the propeller is being put on or taken off, and the rocking beam can also be arrested during these operations to prevent undue wear on the knife-edges. A pointer attached to the rocking bar indicates the error in balance in inch-ounces by steps of ¼ in. oz., up to a maximum of 5 in. oz. in the machine illustrated, though machines are now made to read up to 15 in. oz. With a little practice, the operator can soon judge from the readings how much material must be removed to balance the propeller exactly, or to reduce the error to a negligible amount. The adjustment, we should mention, can be effected without removing the propeller from the balancing machine, so that the operator can see the effect of his work as it progresses. A small dashpot, which can be seen on the extreme right of our illustration, is provided to damp out the oscillations of the propeller, and this is adjusted so that the rocking beam comes to rest in its final position in the shortest possible time. The indications of the instrument are of considerable use in ascertaining the change in balance due to storing propellers under different conditions, and also for determining to what extent errors of balance can be tolerated. Another application for which the instrument may be employed is the matching-up of unbalanced laminations before gluing them together. This process takes the place of matching heavy ends with light ones, and enables a closer balance to be obtained before this stage is reached.

ELECTRIC POWER SUPPLY AT BUENOS AIRES.

WITH characteristic intolerance and with their customary shrewdness in such matters, the Germans had attempted in the decade preceding the war to establish a monopoly in the supply of electric energy for power and lighting in the important city of Buenos Aires. A company was founded on the initiative of the A.E.G. and the Deutsche Bank of Berlin about 1898 under the name and style of the Deutsch-Ueberseeische-Electricitats-Gesellschaft, and the original power station was, as a usual sequel, equipped by the A.E.G.

Within a very few years this German company absorbed one by one the several other rival independent electric supply undertakings which existed in the Argentine capital, including the Compania General de la Cuidad de Buenos Aires, in 1901; the River Plate Electric Light and Tramway Company, and the power and sub-stations of the Anglo-Argentine Tramways, in 1903; the Primitiva Gaz y Luz Electrica in 1904; and finally, the last remaining independent power station, that belonging to the "La Capital" Tramway Company, in 1905. By the latter year the company had established an absolute monopoly in Buenos Aires and sought by every means, including banking and diplomatic pressure, to obtain from the authorities an exclusive concession for the supply of electric energy in the city. In this, be it remarked, they never finally succeeded, thanks to the foresight of the city authorities.

In 1914 the capital of the company had reached the enormous figure of 10,000,000*l.*, and although the A.E.G. had disposed of its capital holding some years previously, the German banks retained the control of the company and with characteristic German Chauvinism looked to it that practically only German or German-Swiss machinery found its way into the power and sub-stations of the company, and German-made cables into the streets of the city. We thus see how the German banks assisted German industry not only by financing such undertakings, but by taking good care that material of German origin should be mainly used in connection therewith.

The intolerance of this monopoly was manifested in more than one way. The company is said on one occasion to have cut off the electric current at the Opera House during a performance because the account had not been promptly met. Other consumers had frequent unpleasant experiences of the arbitrary way in which the Germans used their monopoly to cut off the supply on the slightest pretext. The condition of the transfer of the Anglo-Argentine Tramways Company power station to the D.U.E.G. bound the former company to take the whole of the electric current they required for the operation of their tram lines from the D.U.E.G. for the entire duration of the tramway company's concession, and protected the supply company against increase in the cost of the production of current at the expense of the tramway company. The result of this since the war has been apparent in the history of the Anglo-Argentine Tramways Company, which owing to the increase in the cost of its current supply is no longer able to pay dividends on its ordinary and preferred shares in spite of increased revenue. The dividend of the D.U.E.G., on the other hand, has been maintained at about the same rate as that paid before the war, viz., 10 per cent.

In spite of the great prosperity of the German monopoly and its exceptional financial resources, an Italian engineer, Mr. Giovanno Carosio, A.M.I.Mech.E., ventured to challenge the colossus, and on his initiative the "Compañia Italo-Argentina de Electricidad" was founded at Buenos Aires, the ostensible object, at the time, being the operation

ELECTRIC POWER SUPPLY AT BUENOS AIRES BY THE CIA. ITALO-ARGEN

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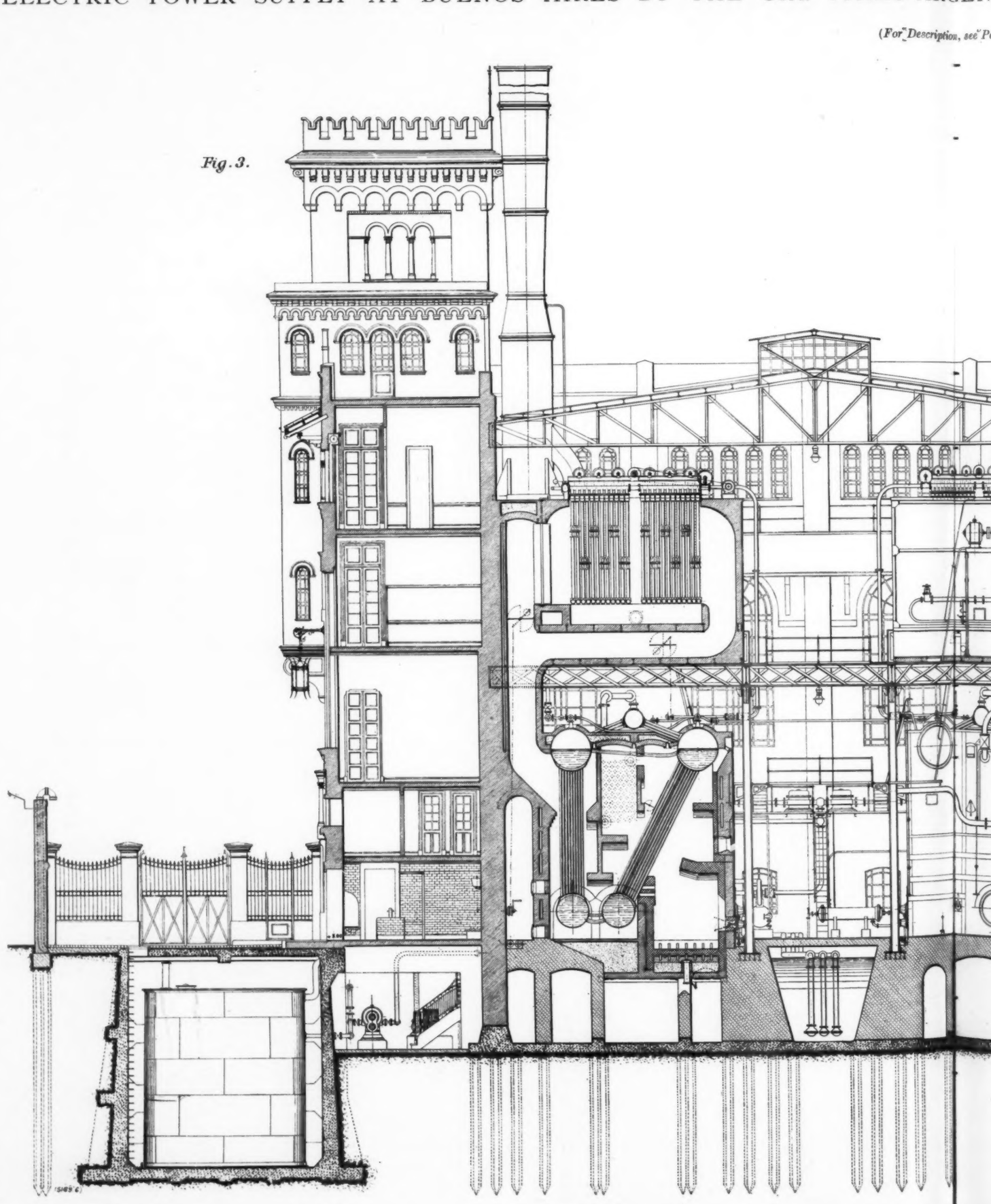
Fig. 3.



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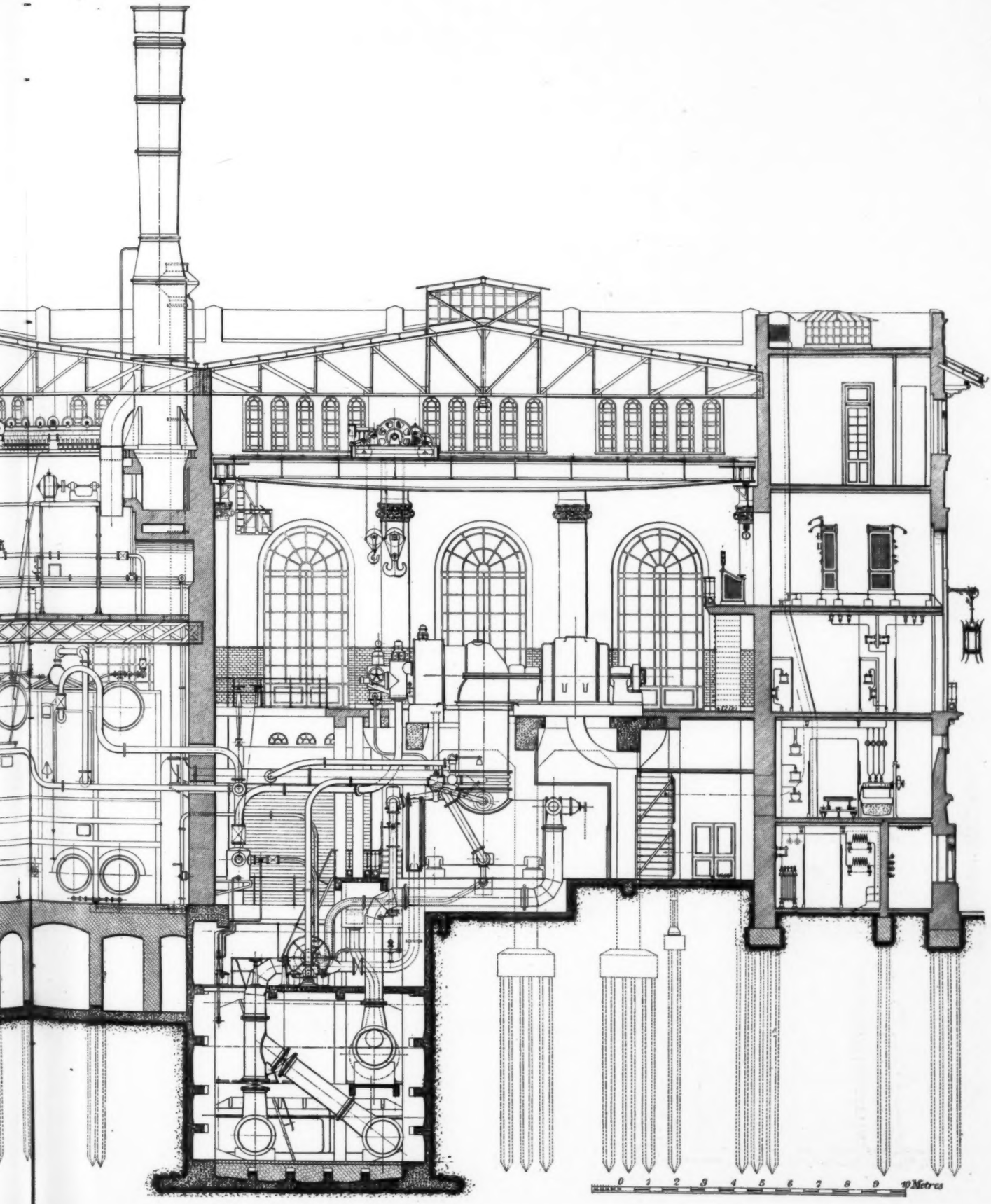

ELECTRIC POWER SUPPLY AT BUENOS AIRES BY THE CIA. ITALO-ARGE

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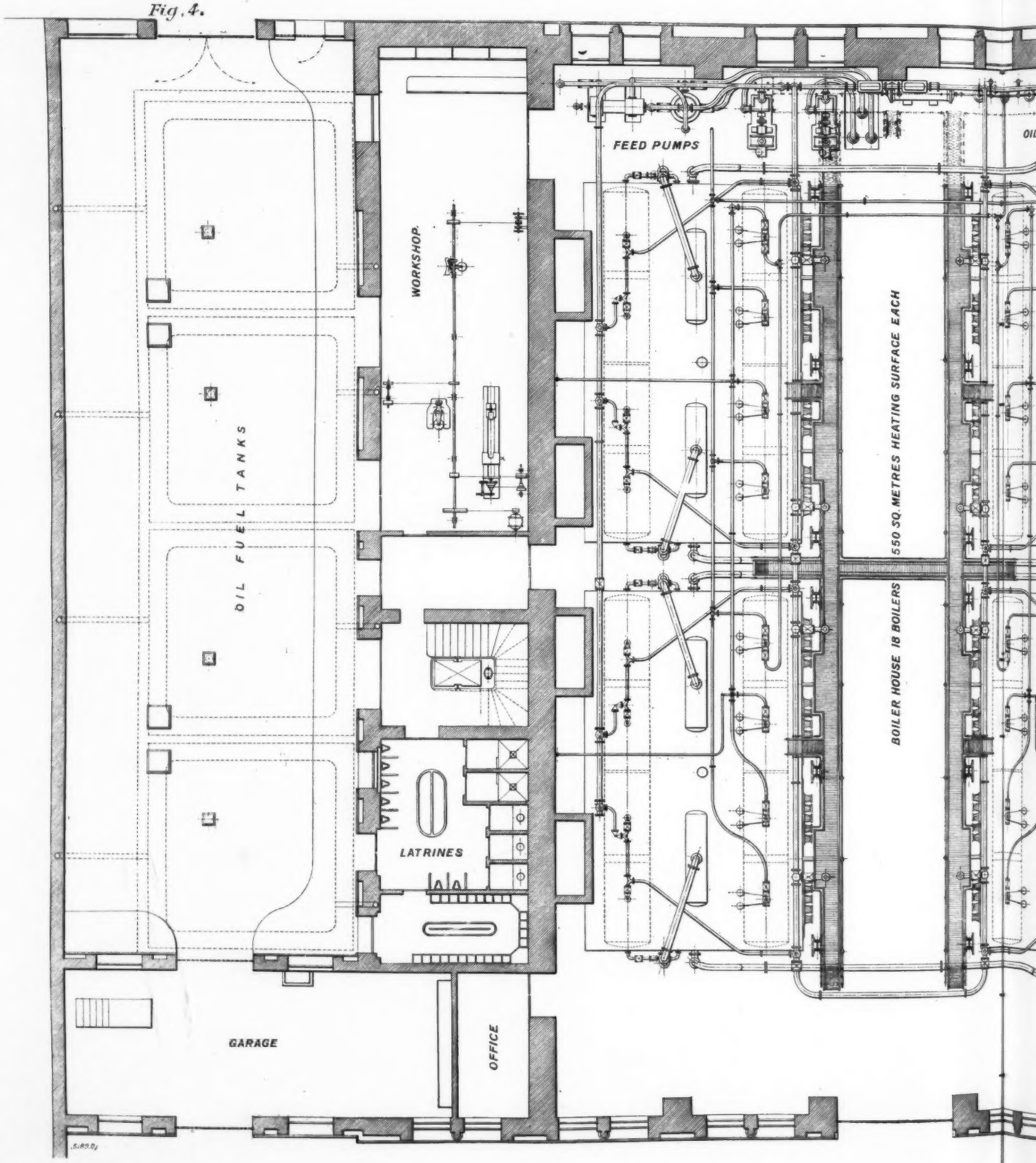
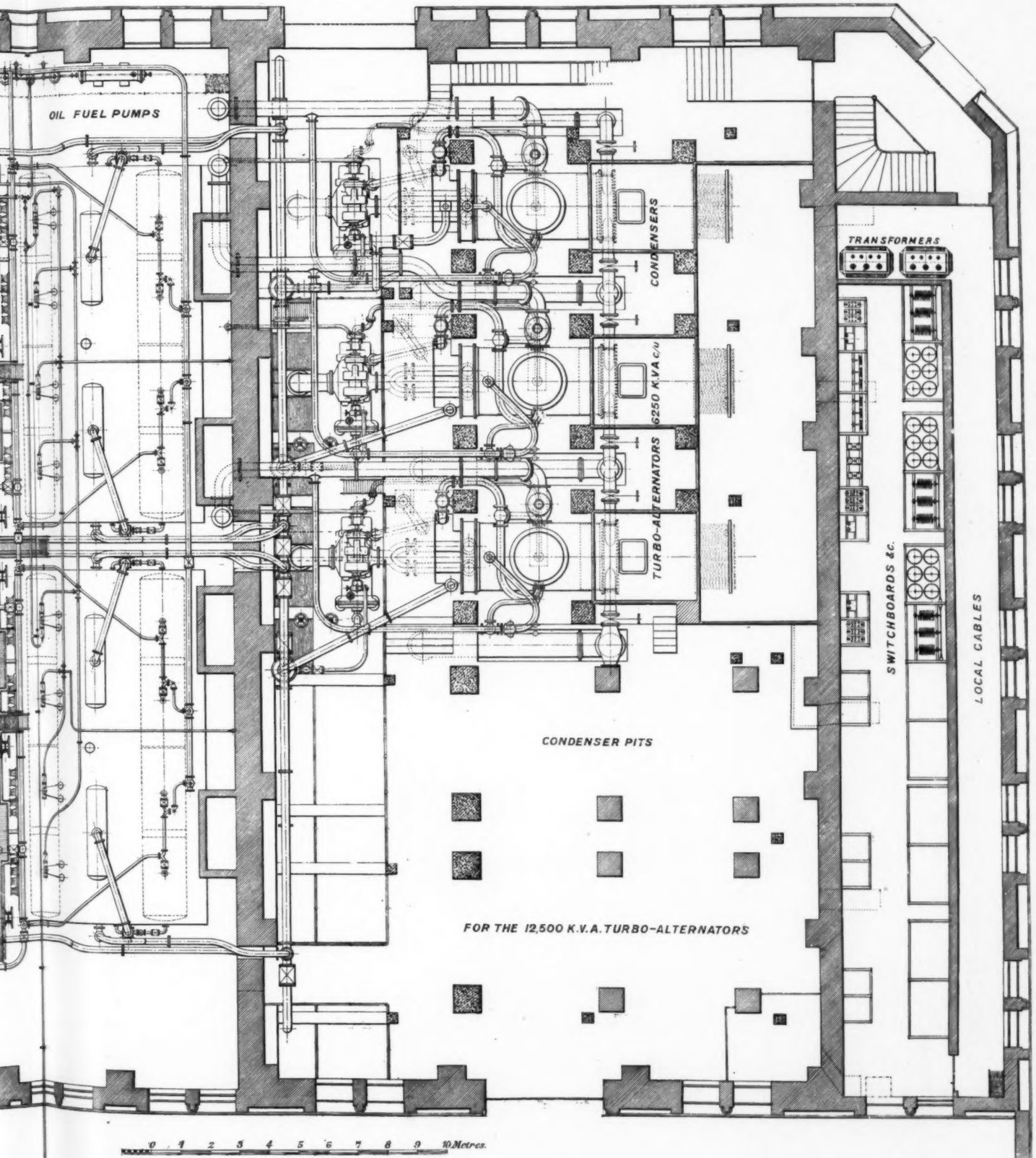
Fig. 4.

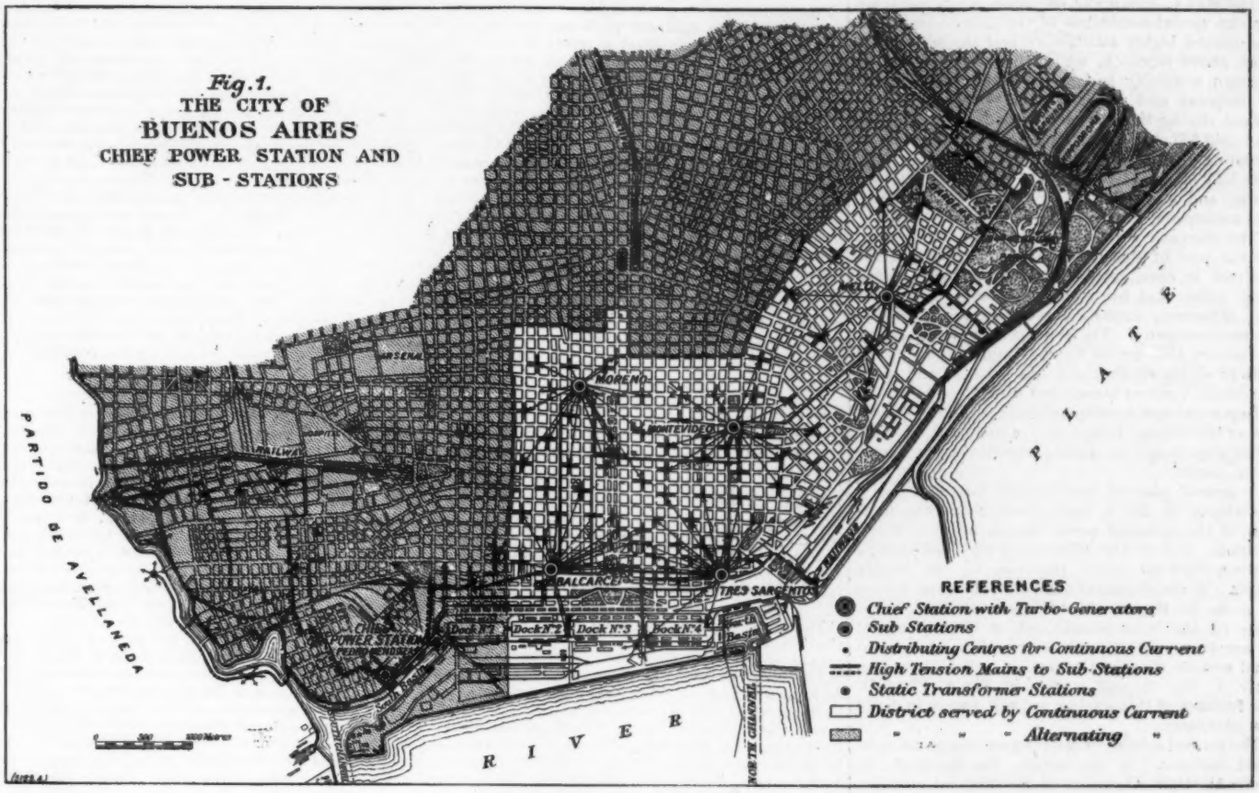


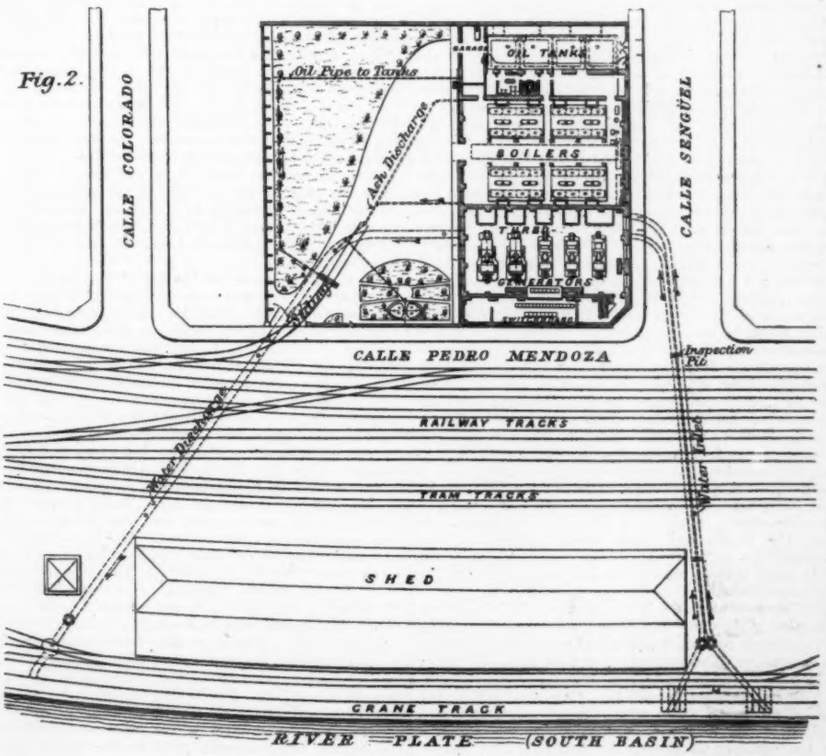
ARGENTINA DE ELECTRICIDAD; THE PEDRO MENDOZA POWER STATION.

(For Description, see *Page* 4.)



ELECTRIC POWER SUPPLY AT BUENOS AIRES.





of power-houses in the interior of the country. The incident accordingly attracted little attention till, having perfected his plans, Mr. Carosio, in 1912, approached the municipal authorities of Buenos Aires, and solicited a concession for the supply of electric current in the city. A very hard fight ensued, the Germans being up in arms immediately and, as is the usual practice with them, sought and obtained the aid of the German Ambassador and the Prussian Government.

Complaint is frequently made that our own diplomatists do nothing to help our contractors in similar situations, but it must be confessed that the direct intervention of a foreign embassy in such cases is a two-edged weapon and frequently causes such annoyance to the parties which it is attempting in this way to coerce, that in the net outcome more harm than good results. In the present case the attempted intimidation failed, the Lord Mayor of Buenos Aires, Dr. Joaquin S. de Anchorena, not being the kind of man to yield to threats where cajolery failed. The new company accordingly obtained the desired concession, and had then to seek for the large amount of capital which would be necessary to finance its proposals. Mr. Carosio was successful in obtaining the backing of some of the leading Italian and Swiss banks; which was accorded on the wholehearted support of the enterprise by such firms as Messrs. Franco Tosi, of Legnano, Pirelli and Co., Credito Italiano, of Milan, and Brown, Boveri and Co., of Baden, Switzerland.

This resulted in the formation of a "Columbus" Trust Company for furthering electrical enterprises, with special reference to the undertakings of the Compañia-Italo-Argentina. The contracts for the electrical part of the installation were awarded to Messrs. Brown, Boveri and Co., and that for the cables was secured by Messrs. Pirelli and Co., whilst Messrs. Franco Tosi supplied the turbines and assumed the responsibility for the design and lay-out of the stations.

It was decided that the plant should be essentially of Swiss or Italian manufacture. One or two small items not procurable in either of these two countries were, however, obtained from Germany, as well as the chimneys, which were acquired before the war. Owing to the conditions following the outbreak of hostilities, other material had to be purchased, the preference being given to England, the meters being obtained from Messrs. Ferranti, Limited, and the boilers from Messrs. Babcock and Wilcox, Limited.

The skill and address required to secure a fair start for the company in the face of the diplomatically-

supported hostility of the German monopoly, has been seconded by similar qualities in the execution of the works; which was, of course, much hampered by the special conditions of the time. The plant has proved highly satisfactory and the service has been above reproach, whilst that afforded by the German monopoly had been for years the subject of frequent and bitter complaint. In 1914 the output during the few months of actual operation was 542,657 kw.-hours, and in 1915 the corresponding figure was 7,251,486 kw.-hours. In 1916 this had increased to upwards of 18,000,000, kw.-hours, and a figure of over 30,000,000 kw.-hours was anticipated for the year that has just closed.

The company supplies the whole of the demand for the port of Buenos Aires, having obtained the contract in open competition and in spite of the usual unfair and below-board pressure, diplomatic and otherwise, exerted by or on behalf of the German company. The principal municipal installations are also served by the Italian company, as well as all the British and Allied banks and other important business houses and stores.

Important new developments are in contemplation, but as the original programme is complete, the time seems appropriate for putting on record a description of the works.

A general plan of the City of Buenos Aires is reproduced in Fig. 1, page 5, and shows the location of the principal power station at Calle Pedro Mendoza, and of the substations and distributing centres, together with the run of the supply mains. A sketch plan of the Pedro Mendoza station is given in Fig. 2. It will be seen that it lies close to the river wharf, and is thus secure of an ample supply of condensing water. A longitudinal section through the station will be found on Plate I, Fig. 3, and a plan in Fig. 4, Plate II. The features of this station we will discuss in detail in a later issue.

The general scheme of distribution comprises some novel features. At the outset, the plans of the Compañia Italo-Argentina de Electricidad provided for the supply of current to a definite sector of the city on the continuous current three-wire system. The current was to be generated as three-phase current at 7,000 volts by a steam turbine plant, and transmitted by high-pressure feeders to five suitably-situated substations, where it was to be transformed into continuous current and distributed on the three-wire system as stated, the potential difference between the outers being 450 volts. The novel feature at these stations was the replacement of booster batteries by Diesel engines which, in addition to helping the main stations over peaks, provided also an independent service which might be of value should the necessity arise. The rapidity with which Diesel engines can be started up made them almost equivalent to batteries, in dealing with sudden and unexpected increases in the load. The whole of the substations are, moreover, interconnected so as to afford mutual help in case of need.

Steps are now being taken to extend the mains of the company into other districts of the city, particularly to the Port of Capital, and before long the company's network is expected to cover the whole of the city. In certain cases provision has been made for supplying large consumers with high-tension alternating current from special mains.

(To be continued.)

RE-OPENING OF THE SCIENCE MUSEUM.—The Board of Education announce that the Science Museum, South Kensington, is reopened to the public on and from Tuesday last, the 1st inst. The museum had been closed to the public for nearly two years: it had, however, been open without interruption for students. As compared with 1914 conditions, the extent and the hours of opening for 1918 are somewhat reduced, but the greater part of the museum will be open free on every week-day from 10 a.m. to 5 p.m., and on Sundays from 2.30 p.m. to 5 p.m. The collections contain many unique objects of great interest as representing discoveries, inventions and appliances that have been of first-rate importance in the advancement of science and of industry. Such objects as Watts' engines, early locomotives, steamships, flying machines, reaping machines and textile machinery are records of British contributions to the progress of the world, and it is gratifying that these can again be made available for inspection by visitors to London from all parts of the United Kingdom and from distant parts of the Empire.

INDUSTRIAL NOTES.

THE committee appointed by Dr. Addison, Minister of Reconstruction, to advise him as to the best method for dealing with post-war problems concerning the chemical trade, have issued a report in which they recommend that the Minister should act in closest collaboration with the representatives of the trade. They name the Association of British Chemical Manufacturers as a body which is most nearly representative of the trade as a whole and with which the Ministry should work in collaboration. They recommend, further, that a standing committee fully representative of all the interests concerned should be appointed as a permanent link between the Ministry and the trade, and that a departmental organisation should be set up in the Ministry of Reconstruction to deal with chemical questions. In charge of this, they suggest, should be a scientific man of good standing who would command the respect and confidence of the trade. This section, working in conjunction with a Standing Committee would, they consider, provide an adequate organisation for dealing with such questions connected with the chemical trade as might come within the Ministry's purview.

The Cotton Control Board recently informed the Government that it will be able to supply labour for the aeroplane factories which it is proposed to put down in the cotton districts. It is stated that the Government will shortly announce the number of buildings which will be required. The board will then be asked to prepare a list of the disused cotton mills which are available and are suitable for conversion into aircraft factories, and to state the districts in which a surplus of labour is available for establishing the factories.

The proposals contained in the recent report of the Coal Conservation Sub-Committee, on the national supply of electric power, have aroused widespread public interest, says *The Newcastle Daily Chronicle*. In Newcastle and the North-East Coast generally they have attracted special attention, as this part of the country is mentioned in the report as particularly illustrating the economic advantages to industries to be derived from the supply of electric energy on a large scale. A great saving of coal has already been effected on the North-East Coast through comparatively recent developments in electric power supply. A representative of the *Chronicle* has had an interview with Mr. R. P. Sloan, a director of the Newcastle Electric Supply Company, Limited, and among the statements made by the latter is one to the effect that unless means were devised for attaining a maximum of economy in the production of electric energy, we should not after the war be able to hold our own industrially in this country. There was an increasing need of cheap power. On the North-East Coast the full development regarding the utilisation of waste heat and gases, &c., had been held up by the war, but after the war there was certain to be further expansion in this direction. Concerning the national control of all electrical undertakings by a Board of Electricity Commissioners, Mr. Sloan said he believed such an authority if it acted in a judicial rather than an executive capacity, would be beneficial to the electricity supply industry, as he believed that a board of that kind would be in a good position to remove or amend restrictive legislation which in the past had very much hampered the development of electrical undertakings throughout the country. In the opinion of Mr. Sloan, the problem of supplying electricity throughout a large area such as the North-East Coast was a totally different one to that of supplying electricity throughout large towns such as Liverpool or Manchester. Without saying that municipal authorities would be unable to deal with the supply of electricity throughout large areas, Mr. Sloan said, no municipal authority had so far had any experience whatever of giving such supplies. In fact the North-East Coast power companies, and possibly one or two other power companies, were the only undertakings which had had that experience to any great extent.

An important point, in the view of Mr. Sloan, was that the generating and supply of electricity should be under one control, whether that control be municipal or company. The control of various areas of supply might vary according to local circumstances.

The representative of the *Chronicle* called the attention of Mr. Sloan to a sentence contained in a published interview with Mr. W. W. Lackie, manager of the Glasgow Electricity Department. Mr. Lackie had stated that: "Municipalities had hitherto been able to sell electrical energy to their consumers at as low rates as companies, and the progressive reduction of the cost of electrical energy must be increasingly in favour of municipalities on account of the manner in which the latter were compelled to repay borrowed capital." Mr. Sloan replied: "This, in my opinion, does not follow. Take the Newcastle Electric Supply Company as an example. I would point out that apart from any sums we set aside out of profits for depreciation or reserve we expend large sums out of revenue each year on improvements, and in renewing obsolete plant, and if we dealt with our accounts on the same lines as municipal authorities our results would appear more satisfactory than those of a large number of the municipal undertakings which are credited with being run on the most sound financial lines." The assertion that "companies were out to make as big dividends as possible, whereas municipal concerns, from their very nature, were there to serve the interests of the consumer, and these in the long run were the national interests," was pointed out to Mr. Sloan, and he remarked: "I may say if companies are out to make as big dividends as possible they will never secure customers, and it is only by securing customers that they can increase their turnover and thereby improve their profits. Further, in the event of the scheme outlined in the report being brought into operation there is no doubt that some steps would be taken to regulate the dividends paid by electric supply companies in a similar manner to the regulation of dividends in the case of the gas industry."

In an interview with a representative of *The Yorkshire Post*, on the same report of the Coal Conservation Sub-Committee, Mr. T. Roles, electrical engineer and manager for the Bradford Corporation, stated that the advantages of private enterprise had been extolled and recommended, whilst municipal achievements had been most unfairly criticised and decried. It should be remembered, he added, that many of the restrictions which had hampered the municipal concerns had been due to legislation prompted by private interest. A table in the report compared Lancashire municipal undertakings with those of the North-East Coast companies, to the great disadvantage of the former. The comparison was made on the basis of the average price charged to the consumer, a basis which, Mr. Roles said, no one acquainted with the business would accept. In the case of the corporations, the supplies included large quantities sold for lighting and small power purposes, which, owing to the cost of distribution, had to be charged for at considerably higher prices than were charged for bulk supplies to large consumers, for which, in most cases, no low-tension distribution cables were required. It should be remarked also that not only had many of the municipal undertakings supplied electricity at very cheap rates, but all such undertakings had been obliged to contribute liberally to sinking funds, with the result that in many instances about half of the total capital of the undertakings had been written off. On the other hand, Mr. Roles said it was a notorious fact that the amount written off for depreciation by most company concerns, especially the North-East Coast companies, was far below that which would be dictated by sound finance.

According to Mr. Roles there was reason to doubt the correctness of the estimates of savings in coal and money which, according to the report, should be at least 55,000,000 tons of coal, and 100,000,000*l.* a year; but he was of the opinion that the savings would be very considerable.

On the question of site the report laid emphasis on the desirability of power stations being on important waterways; but Mr. Roles thought it more important that the power station should be erected as near as possible to the load to be supplied, on account of the capital cost of high-pressure mains, and the losses in transmission. On the other hand, Mr. Roles admitted that in Bradford, at Shipley, at Leeds, and other neighbouring stations the present sites were not suitable for the development of electro-chemical processes, or for the installation of plant for the extraction of by-products from coal, and he agreed that it seemed a sin not to extract the by-products before the coal was used for the production of electricity. Bradford was using 80,000 tons of coal a year, and the by-products of that coal were simply wasted. Mr. Roles was not convinced that the estimate of the saving of coal made in the report would be realised. The estimates were based on the present consumption of coal throughout the country, averaging 5 lb. per indicated horse-power hour, but figures which he had obtained from 18 different textile works in the Bradford district, showing a total indicated horse-power of over 28,000, gave an average consumption of coal per indicated horse-power hour of only 2¼ lb. The figures regarding the saving, and, in fact, the financial aspects of the whole scheme, should, he thought, be gone into very carefully before the scheme was proceeded with to the fullest extent recommended in the report.

The recommendation of the report that the new authorities to be set up should in addition to controlling generation, also control main distribution, in Mr. Roles' view went too far. These authorities should control generation and transmission only, leaving the distribution in the hands of the present

supply authorities. Of the various suggestions in the report for district control, Mr. Roles favoured the formation of a local board, representing all interests, both company and local authority.

The report for December of the Steam Engine Makers' Society states that the membership is now 23,500, distributed over 203 branches. The capital of the society is 240,000*l.*, equal to 10.4*l.* per member. The society has expended in benefits 870,000*l.* There were at the date the report was issued only five unemployed members on the lists. The society now enters into its ninety-fourth year.

A pamphlet on protective clothing for women and girl workers employed in factories and workshops has recently been prepared by the Home Office from information supplied by H.M. Inspectors of Factories. The pamphlet covers 31 different employments, arranged alphabetically, from aeroplane work to textile and allied processes; it gives in each case the nature of the risk run and the type of clothing recommended by reference to illustrations. The price of the pamphlet is 3*d.* net.

About 10,000 men in the Sheffield steel and iron trades were on strike at the time of writing owing to the Government declining to extend to those trades the 12½ per cent. bonus which the employers were willing to concede. A meeting of the men was held last Tuesday, at which the following resolution was passed: "That this mass meeting reaffirms the decision arrived at by members of the Iron and Steel Trades' Federation at their meeting held on December 26, and decides not to resume work until the Government agrees to concede the 12½ per cent. bonus on the lines recommended by the Sheffield Employers' Association."

THE INSTITUTION OF CIVIL ENGINEERS.—On January 2 the Institution of Civil Engineers completed the hundredth year of its existence, having been established in 1818 at a meeting of eight engineers at the Kendal Coffee House in Fleet-street. At the next ordinary meeting of the Institution, on January 8, before the discussion of papers, a statement commemorative of the founding of the Institution on January 2, 1918, will be made, present conditions precluding more formal celebration of the centenary.

TRANSACTIONS OF THE INSTITUTION OF NAVAL ARCHITECTS.—Vol. LIX of the Transactions of the Institution of Naval Architects has just been issued from the offices of the Institution, 5, Adelphi Terrace, London, W.C. 2, and it is a gratifying proof of the vitality of the Institution that, notwithstanding the insistent claims of the war and the need for secrecy in the great developments of the moment, particularly in naval architecture and engineering, the contents are so voluminous, varied and instructive. The volume is, of course, primarily taken up with the complete report of the Spring Meeting when 13 papers were read and discussed. A feature of the volume this year is, perhaps, the number of communications made since the meeting in reference to several of these papers, due to many of the members being precluded by war work from attending the meetings, and to the fact that several of the papers were by foreign members who could not attend and reply *viva voce* to the discussion. The frontispiece is a strikingly characteristic portrait of Engineer Vice-Admiral Sir John Durston, K.C.B., who died soon after the meetings were held; and in addition to the obituary notice of him there are also notices and portraits in the volume of the late Sir William Theodore Doxford, vice-President, Sir Benjamin C. Browne, a member of council, and Mr. James Gilchrist, also a member of council. There are 86 plates of drawings, diagrams, &c. The secretary of the Institution, Mr. R. W. Dana, who edits the volume, is to be congratulated upon his work.

"THE FLEET ANNUAL."—The third great war number of "The Fleet Annual and Naval Year Book" for 1917 has just been published for the "Fleet" by Chapman and Hall, Limited, 11, Henrietta Street, Covent Garden, W.C., at 4*s.* net. This is the twelfth year of the annual, and, as in former years, it has been compiled by Mr. Lionel Yexley. The circumstances practically preclude any original contributions to such annuals, but the issue will be welcomed because, for the third year of the war, it brings together all the official data, and thus must serve as a handy book of reference. The first part gives, in chronological order, a record of every event, in the words of the official *communiqués*, of the naval war, and interspersed are portraits of men who have, by heroism, maintained the traditions for bravery of the Navy service. Following this record is a special review of the submarine warfare *à outrance*, tables of navy separation allowances, regulations as to naval prize money, and the despatches reviewing naval operations, giving, of course, the names of those mentioned in such despatches. Finally there is a complete record of the honours awarded during the year. The usual tables of the fleets of the world are repeated, and, as far as possible, the ships lost are printed in italics: but these, being for the most part pre-war tables, are not of much use. An acceptable appendix is that giving, under the appropriate title of "The Navy's Immortal Names," the names of the men who have been killed in the war during the year.

AGRICULTURAL TRACTORS.

*An Agricultural Power Unit. Some Factors Governing the Design of a Small Tractor.**

By ALAN E. L. CHORLTON, C.B.E.

THE problem of providing mechanical power, to replace that of the horse, &c., in the most suitable and efficient form for the purposes of agriculture, is one of no inconsiderable difficulty, the guiding factors being such variables as the size of the farm, the class of land, the nature of crop, road transportation and the financial ones of first cost, annual charges, &c. The information relating thereto is so diverse, so variable and difficult to relate to actual fact (it seems more often a matter of opinion rather than fact) that the mechanical engineer investigating the problems on lines he is accustomed to, finds himself at some loss where to begin, and is driven in the end, owing to this lack of precise information, to provide much of the essential data by actual experiment.

In the preparation of this paper, which was undertaken at the request of the president, the author has found the difficulty of obtaining this precise information to be very great indeed. If such information does in reality exist, it would have saved him much trouble had he had the good fortune to have access to it. Undoubtedly, there is, apart from the actual mechanics of the problem, a considerable divergence of opinion as to the manner in which the problem should be met, whilst, agriculturally, the views held are seldom accompanied by those proofs upon which any engineer would rely.

In this problem, the difficulty of bringing together the agricultural expert and the mechanical engineer is a very real one. This difficulty is reflected in the tardy progress in this country of mechanical agricultural science, which apart from the conservatism of the farmers themselves, has undoubtedly depended upon the cut-and-dry methods so familiar in the past, and not upon scientific and technical research, the need for which at the present day is so prominently before us, and in connection with which we are so constantly admonished by the daily press.

Though in the main the views held by farmers may be divided into two groups, those who favour a special power implement for each purpose and those who think a general purpose machine should be provided to deal with each and all, yet the problem should undoubtedly be considered, in the first instance, from the standpoint of capital expenditure and annual charges. The average farm in this country is comparatively small, and the farmer may find it financially impossible to purchase a special power-driven implement for each of his requirements, even should he be of opinion that such a policy is a desirable one. For example, if a light tractor were purchased for ploughing alone, then a power unit would be needed for threshing, whilst on the road provision must be made for the mechanical power required for transport. A fourth power unit may even be required for other purposes, thus, a first cost of, say, 350*l.* per unit might be increased approximately to 1,050*l.*, or even to 1,400*l.*, whilst the yearly writing-off of capital, interest, &c., would be increased proportionately, each requirement now having to bear the full charge of its special machine. The effect on the working costs of the writing-off of so large a capital expenditure incurred by unipurpose machines is very material: for example, the capital charges for a tractor costing 350*l.* suitable for ploughing alone, and allowing seven years' life, and 100 acres per year, would be 10*s.* per acre, for 200 acres 5*s.* per acre, and even if an allowance is made for performance of light land work, subsequent to ploughing, the cost would probably amount to 3*s.*, equivalent to the cost of fuel (at 3 gallons per acre), and as great as, if not greater than, the wages of two operators.

The financial consideration of the problem brings out the advantages of a multi-purpose machine, a power unit—if it could be designed—to meet the majority of calls of the farmer, instead of a special power implement for each purpose. Such a desirable combination should never be lost sight of in any general investigation of the fundamental factors of design.

Though beginning with the general aspect, the progress of the investigation revealed the extent of the field covered by the application of mechanical power to agriculture as too wide for the scope of this paper and the time at the disposal of the author, and it was, therefore, in the end, as the financial aspect was considered so important, narrowed down in the main to a consideration of the possibilities of a single power unit which would meet the majority of the demands called for on the farm. There will always be farms so large or special conditions of such a nature as to allow of the purchase of special machines for each purpose with a commercial advantage: such cases, however, must be considered individually, and are not dealt with here. There is no doubt, however, that despite the questionable soundness from a commercial point of view, of the use of many special-purpose units for the average farm, there still remains a strong body of opinion that the use of such power implements is the right thing, and only the showing of the future, when the farmer has purchased on these lines, will clearly demonstrate whether due consideration had been paid to the financial aspect of the problem.

It is essential to bear in mind the incidence of the various duties called for from the tractor: will they so fall as not to conflict? That is to say, can the uses of such a power unit be reasonably well divided to cover the agricultural year with the help of horses which will be always available to a limited extent? It is held that they can, though each farmer must with his own conditions in front of him judge for himself. The requirements called for from a power unit during the agricultural year are:—

(*a*) Ploughing, dragging, rolling, drilling.
(*b*) Reaping, binding and leading.
(*c*) Threshing, pumping, pulping, chaff-cutting and grinding.
(*d*) Transport work to the station.

These duties are not likely to exceed 70 per cent. of the total working days of the year.

It is not possible here to consider these operations in further detail, for we must confine our examination to the mechanical factors of the problem. The three principal uses which, by their requirements, govern the design of the tractor are:—

(*a*) Road work—transport.
(*b*) Land work—ploughing.
(*c*) Farmstead—threshing, &c.

(*a*) governs the minimum axle loading, (*b*) governs the maximum axle loading, (*c*) governs the minimum power required.

1. ROAD WORK.

The basic factors governing the application of mechanical power for traction purposes are adhesion and resistance.

Tractive Adhesion.—The adhesion of the driving wheels on the road must be sufficient to utilise the power developed by the engine in overcoming the tractive resistance of the load and the tractor combined. There exists a considerable amount of data relating to tractive resistance, but for tractive adhesion on common roads, little, if any, can be found. For traction on rails, the locomotive engineer has plenty of data obtained by the use of dynamometer cars, and from these have been developed recognised constants. The standard figure of adhesion is 0.25, *i.e.*, one-quarter of the load on the driving axles can be used in drawbar-pull. It is stated that this figure rises to 0.35, but it is not advisable to use such a value in practice.

TABLE I.—*Typical Results for Various Surfaces.*

Test No.	Kind of Road.	Condition of Road.	Location.	Traction Resistance.	
				Total	Per Ton.
29–30–31	Concrete (unsurfaced)	Smooth, excellent	Near Davis	83.0	27.6
*11–12	Concrete (unsurfaced)	Smooth, excellent	Near Davis	90.0	30.0
26–27–28	Concrete (½-in. surface asphaltic oil and screenings)	Smooth, excellent	Near Davis	147.6	49.2
13–14	Concrete (½-in. surface asphaltic oil and screenings)	Smooth, excellent	Near Davis	155.0	51.6
9–10	Macadam (water-bound)	Smooth, excellent	Near Davis	193.0	64.3
22–23	Topeka on concrete	Smooth, excellent	Near Davis	205.5	68.5
8	Gravel ..	Compact, good condition	Near Davis	225.0	75.0
†45–48	Oil macadam	Good, new	Near Sacramento	234.5	78.2
‡46–47	Oil macadam	Good, new	Near Sacramento	244.0	81.3
33	Gravel ..	Packed in good condition	Near Davis	247.0	82.3
18–19–20	Topeka on plank	Good condition, soft, wagon left marks	On Causeway, near Davis	265.0	88.3
34	Earth road ..	Firm, 1½ in. fine loose dust	Near Davis	276.0	92.0
24–25	Topeka on plank	Good condition, but soft	Near Davis	278.0	92.6
1–2–3	Earth road ..	Dust ¾ in. to 2 in.	Near Davis	298.0	99.3
3–4	Earth ..	Mud, stiff, firm underneath	Near Davis	654.0	218.0
6–7	Gravel ..	Loose, not packed	Near Davis	789.0	263.0

* Graphic record indicates that the load was being accelerated when the test was stated.
† Drawn with motor truck at 2½ miles per hour.
‡ Drawn with motor truck at 5 miles per hour.

As no adhesion values were available for steel tyres on common roads, experiments have been made to determine them. In these experiments a steam tractor was employed towing a loaded wagon by means of a recording dynamometer. In order to obtain maximum results the experiments were extended so as to traverse a steep hill, and even with this additional resistance it was still necessary to apply the brake to the wagon before the maximum value was exceeded, and slipping began. It will be seen clearly that these experiments also afforded an opportunity of testing traction resistance constants, and this was done. To make the results still more useful, the same tractor was fitted with rubber-tyred wheels and tested under similar conditions. The whole forms quite a useful combination of data for the designer of tractors for common roads, and the author is much beholden to Messrs. Ruston, Proctor and Co.

* Paper read before the Institution of Automobile Engineers.

for enabling the tests to be carried out. These results are shown in the diagrams of experiments, Figs. 1 and 2.

From these it will be seen that the maximum value—*i.e.*, with slipping just beginning—is for steel tyres 0.56, and for the rubber tyres 0.6. It is suggested that in practice where country roads have to be taken into account, a safe value for steel tyres would be 0.45, and for rubber tyres 0.55, or if long life of tyres is desired 0.5. This means, in effect, that in getting out the design of the tractor for road transport, which duty limits the minimum weight, the propulsive effort cannot be taken as exceeding 0.45 times the weight on the driving axle for steel tyres. The high cost of rubber tyres for road purposes with their special wheels seems hardly justifiable for the conditions obtaining on a farm.

Traction Resistance.—From the experiments, Figs. 1 and 2, the tractive resistance for a good macadam road comes out at just over 50 lb. per ton, the diameter of the hind wheels of the loaded wagon being 4 ft. by 9 in., that of the front 3 ft. 6 in. by 9 in., with steel tyres. The values given in Table I (see page 7) are the results of experiments lately carried out over roads in California. For the purposes of this investigation a value of 60 lb. per ton has been taken.

Having now the values for adhesion and resistance, it is necessary to inquire as to the load a farmer will require for road transport. As it is desirable that the tractor should work on the land with practically the same efficiency as a special-purpose machine, heavy axle loading is prohibited, and it becomes necessary to proportion the tractor weight to fulfil this condition, and yet permit of the requisite adhesion for hauling the load on the road.

When the tractor is hauling a wagon in ordinary service the load may be adjusted to any condition or gradient. Is there, however, any other governing condition in which this adjustment cannot be made. A load that is in one, so to speak—and here a full-sized 4-ft. 6-in. threshing machine may be taken as a guide—such a machine weighs 4½ tons, as a safe maximum, say, 4.5 tons.

The next consideration is the reasonable maximum gradient a tractor may be called upon to face. If a maximum gradient of 1 in 10 and a tractor weight of 50 cwt. is assumed, we have 224 + 60 = 284 lb. as the total resistance per ton. Then the total load of 4.5 tons plus 2.5 tons equals 7.0 tons, or a total propulsive effort of 1,988 lb., which gives us, with a 0.45 traction adhesion, a load of 4,400 lb., on the driving axle. Obviously with a tractor of a total weight of but 2.5 tons (say 15 cwt. on the front axle and 35 cwt. on the back), this axle weight cannot well be provided. The increased loading on the axle due to the reaction of the drive, the values of which are shown in Fig. 3, provides, however, a means of meeting this difficulty. The alternative method is to adopt artificial loading on the axle. Resolving the drawbar pull into engine power at 2 miles an hour, at 70 per cent. gearing efficiency we get a brake horse-power of the engine of 15.2, and at 80 per cent. efficiency the power would be 13.2 approximately. For still heavier loads or steeper gradients a larger power is required, and it is desirable therefore that this be provided if not incompatible with the other factors.

2. Work on the Land.

The governing factors of successful working on the land are not easily determined, and apart from the difficulty of carrying out experiments there are such intangible things as the varying opinion as to allowable pressure on the soil to be taken into account.

It may be said generally, however, that weight is a very important consideration, and must not exceed a certain maximum, whilst additional tractive effort in excess of that consistent with this weight, must be obtained by other means, projections on the wheels, spuds, &c.

The pressure which worked land will bear without injurious effect upon the crops, varies, of course, according to the nature of the soil. From the mechanical point of view the limit of pressure is set by the necessity to prevent sinking into the ground, an occurrence which is seldom due to excessive weight. What usually happens is that owing to inadequate gripping power the driving wheels rotate and act as milling cutters, scraping out the soil from beneath.

The relative values of weight and spud area are very difficult to allocate so as to be able to make comparisons. For instance, a machine with a 30-cwt. axle loading and short spuds pulls partly by adhesion and partly by grip, and the latter is rendered more effective by the weight of the wheel holding the ground down during this action. On the other hand, a lighter tractor with 15-cwt. axle loading must pull very largely by grip alone, and the effectiveness of the grip is modified and reduced by the lighter weight behind it, and the greater rolling resistance per ton set up by the spuds. Hence it will be seen that the data to be ascertained are the proper relation of pressure on the land, the pressure against it, and the action of the rim projection, strake, spud or grouser.

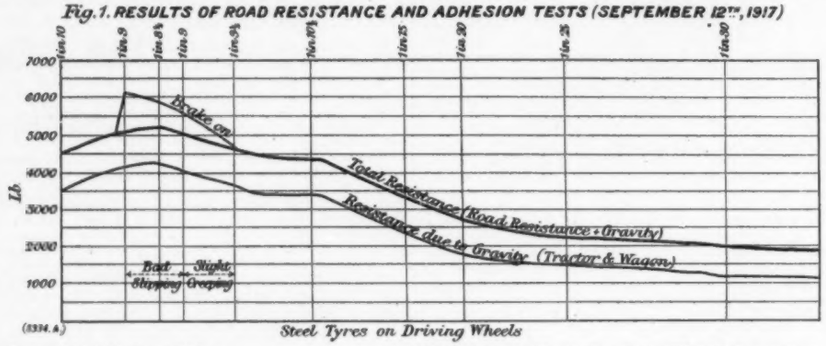
We have thus three prime conditions to be met for the majority of cases:—

(*a*) Driving axle loading.
(*b*) Pressure against grips or spuds.
(*c*) Effect of rolling resistance.

Considering first pressures that have been usual on land work, we have:—

	Lb. per Sq. In.
Man's shoes	8.5
Horse's hoofs	20
Cart tyres—	
Load 2 tons	40

Fig. 1. RESULTS OF ROAD RESISTANCE AND ADHESION TESTS (SEPTEMBER 12TH, 1917)

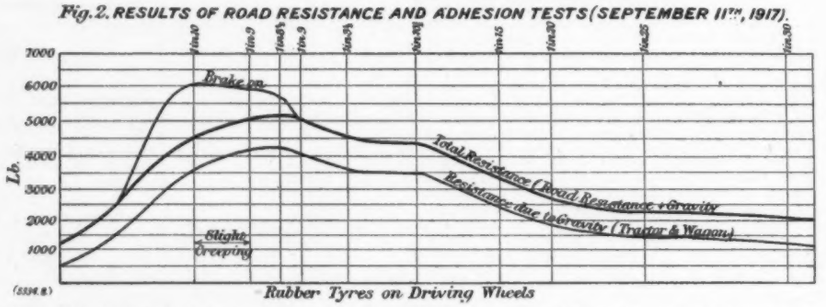


Steel Tyres on Driving Wheels

Gross weight of tractor = 7.4 tons.
Gross weight of wagon = 8.7 tons.
Gross weight of complete train = 16.1 tons.
Weight on driving wheels (3 ft. 6 in. × 12 in.) = 10,000 lb.

Adhesion factor, without slip = 0.46. With slight creeping = 0.56. Max. = 0.62.
Road resistance per ton, av. = 53 lb.
Average speed = 1¾ m.p.h.
Road surface, very good macadam, dry.

Fig. 2. RESULTS OF ROAD RESISTANCE AND ADHESION TESTS (SEPTEMBER 11TH, 1917).



Rubber Tyres on Driving Wheels

Gross weight of tractor = 7.4 tons.
Gross weight of wagon = 8.7 tons.
Gross weight of complete train = 16.1 tons.
Weight on driving wheels (3 ft. 4 in. × 10 in.) = 10,000 lb.

Adhesion factor, without slip = 0.58. With slight creeping = 0.6.
Road resistance per ton, av. = 53 lb.
Average speed = 1¾ m.p.h.
Road surface, very good macadam, dry.

Fig. 5 REDUCTION REQUIRED FOR 2 M.P.H. 64 TO 1 APPROX.

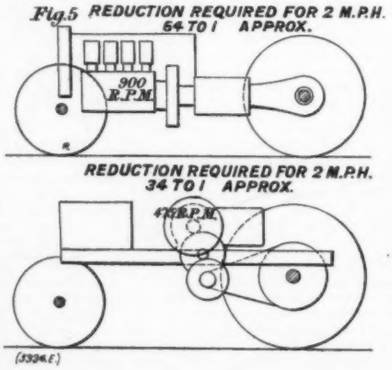
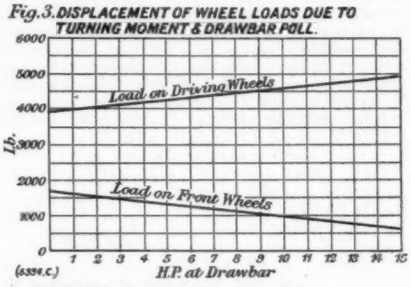
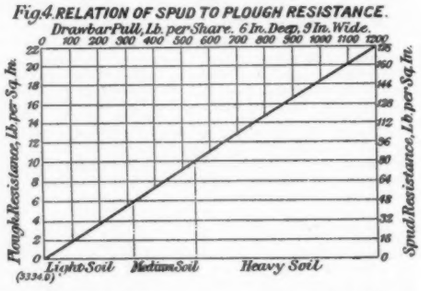


Fig. 3. DISPLACEMENT OF WHEEL LOADS DUE TO TURNING MOMENT & DRAWBAR PULL.



Weight of tractor in working order, 2½ tons.
Wheel base, 6 ft.
Diameter of driving wheels, 4 ft.
Height of drawbar from ground, 1 ft. 8 in.
Power lost in rolling resistance taken as 20 per cent.

Fig. 4. RELATION OF SPUD TO PLOUGH RESISTANCE.


Drawbar Pull, Lb. per Share. 6 In. Deep, 3 In. Wide.
0 100 200 300 400 500 600 700 800 900 1000 1100 1200
Plough Resistance, Lb. per Sq. In.
Spud Resistance, Lb. per Sq. In.
Light Soil
Medium Soil
Heavy Soil
(3334.D.)

	Lb. per Sq. in.
Oil tractor in use—	
3 tons on axle	25
With extension	16
Steam tractor—	
3.5 tons on axle	17

Assuming from our previous figure a static axle loading of 3,920 lb., then with the driving wheels of the tractor 48 in. diameter by 12 in. wide, we get, with a contact area of 288 sq. in. (sinkage of wheel ¾ in.), a pressure per square inch of 13.6 lb.

The second part of the problem is more difficult owing to the absence of data, but concluding that the strength of the ground is represented by its resistance to ploughing, Fig. 4 is useful.

Considering first pulling by grip alone (light tractors in Fig. 5) the suggested allowable pressures against a spud are given, and for average land 50 lb. to 75 lb. per square inch may be taken as corresponding to approximately a plough resistance of 9 lb. per square inch. If it is assumed that the drawbar pull is 2,000 lb., and the loading 50 lb. per square inch, the pull if taken by one spud in each wheel would be 1,000 lb., so that for a 12-in. wide wheel the spud would be 1.67 in. long for average land.

For light lands when the strength of the soil is low, with the same drawbar pull, this depth would have to be increased about four times, *i.e.*, the spud would be 6.7 in. based upon the relative resistance given in the above table. This cannot be considered as a proposition to be recommended owing to the necessarily greatly increased rolling resistance of the tractor, and a special device becomes necessary, such as an actuated spade, Fig. 6, fitted to the driving wheels, if efficiency is to be obtained. The mechanical complication and disadvantages of this method, even though they may be surmountable, are self-evident.

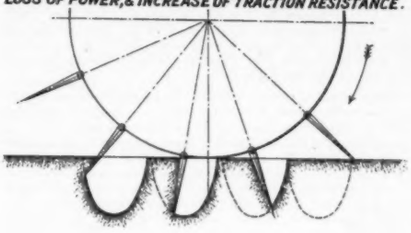
There is no doubt that many useful experiments can be carried out to determine the most efficient form of grip for varying conditions of soil and weight of tractor. On very soft land the wheeled tractor, either by reason of weight or spud pressure, is not suitable, and one of the caterpillar type becomes essential. This, however, cannot be said to be at all necessary for the majority of English agricultural conditions.

From the tests at 2 m.p.h. (see Fig. 7) when the drawbar pull is 500 lb. per share, the curves in Fig. 8 have been got out in which the important effect of gradient is indicated. For four shares and a gradient of 1 in 10 it will be noted that the load at the engine is 23 brake horse-hower, and it is desirable that this should be obtainable if not inconsistent with the other governing factors of the design, for with four shares instead of

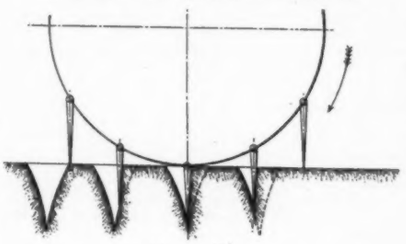
three, 25 per cent. extra ploughing will be effected for the same cost of labour.

From the tests made in dragging the tractor, the 900-lb. drawbar pull for a 3½-ton tractor is equivalent to a rolling resistance of 277 lb. per ton on land. As the tests show the loss in the gearing of the tractor is 32 per cent. of the total power, had the gear of this tractor been constructed on the lines of motor-car practice

Fig. 6.
EFFECT OF FIXED RADIAL PROJECTIONS INDICATING LOSS OF POWER, & INCREASE OF TRACTION RESISTANCE.



ACTUATED PROJECTIONS. PARALLEL MOTION.



ACTUATED PROJECTIONS. ECCENTRIC OPERATION.

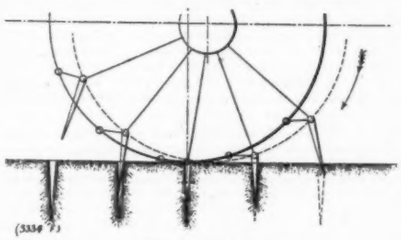
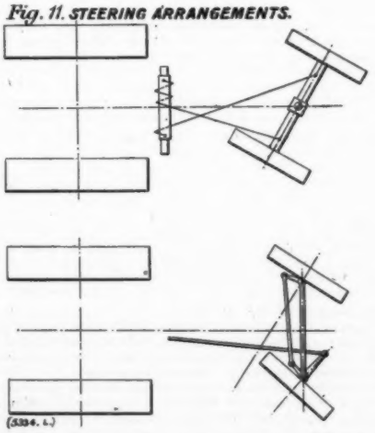


Fig. 11. STEERING ARRANGEMENTS.



a considerably higher efficiency would have been obtained.*

From the other test at 1.57 m.p.h. the drawbar pull is 2,300 lb., or 766 lb. per share, the drop in speed allowing the engine to deal with the stronger land. The peakiness of this curve shows the value of large flywheel effort on the engine.

3. Work on the Farmstead.

The highest power which a tractor when acting as a stationary power unit is called upon to provide, is generally accepted as that for threshing.

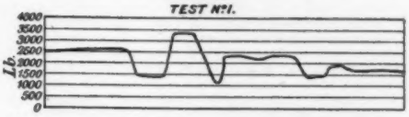
Diagram, Fig. 9, gives an approximate power curve for different sizes of threshing machines. From this it will be seen that 20 h.p. is not exceeded, though it is usual to allow 25 h.p. for large machines. For grinding the powers are less.

Summing up now, and allowing a margin of safety on the results so far arrived at, the fundamental values for the multi-purpose tractor may be taken as :—

	Power Required. h.p.	Driving Axle Loading. Lb.
Road work ...	... 18 to 20	4,400
Land work ...	... 23 to 25	4,400
Farmstead ...	... 20 to 25	Stationary.

Fig. 7. TESTS OF TWO-CYLINDER PARAFFIN TRACTOR

TEST No 1.



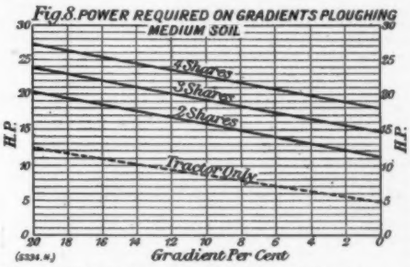
Ploughing at 1.57 m.p.h. in stubble. Stiff clay land.
Mean drawbar pull, 2,300 lb.
Mean drawbar h.p. = 9.65 = 3.21 h.p. per share.

TEST No 2.

Ploughing at 2 m.p.h. in stubble. Medium soil.
Mean drawbar pull, 1,500 lb.
Mean drawbar h.p. = 8 = 2.66 h.p. per share.
Rolling resistance of tractor with spuds on = 277 lb. per ton.
Power used in ploughing = 8.0 h.p. = 42.5 per cent. of total h.p.
Power used in rolling res. = 4.8 h.p. = 25.5 per cent. of total h.p.
Power used in transmission = 5.95 h.p. = 32 per cent. of total h.p.

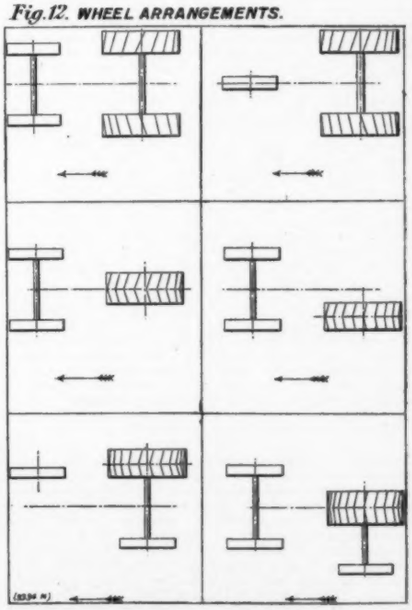
Weight of tractor, 3½ tons.
Weight on driving wheels, 5,000 lb.
B.h.p. of engine = 18.75.
Driving wheels, 4 ft. 6 in. dia., 15 in. wide.
Plough, Ransome three-share, cutting 6 in. deep, 9 in. wide.

Fig. 8. POWER REQUIRED ON GRADIENTS PLOUGHING MEDIUM SOIL.



Weight in working order with three-share plough, 3 tons.
Ploughing speed, 2 m.p.h.
Rolling resistance of tractor with spuds on, 280 lb. per ton.
Furrows, 6 in. deep, 9 in. wide. Gearing efficiency, 80 per cent.
Pull required per share, on stubble land, 500 lb.

Fig. 12. WHEEL ARRANGEMENTS.



Though the following observations are not fundamental they form very important considerations in the design of a tractor.

The Engine.—Any consideration of the engine must begin with the conditions under which it has to run on a farm, the inexpert attention likely to be given to it being an important factor. Generally, whilst this necessitates robust construction, it also calls for a low power rating or a considerable reserve of power, and probably the factors of low speed, large cylinder capacity for power required, strength and simplicity of parts are the main ones. That the engine must operate on paraffin is a *sine qua non*, and further, it is preferable that it should develop its power without water injection.

The gain to be obtained by the use of crude oil in a high compression engine would justify the greater refinement of the engine, though there is greater difficulty

Fig. 9. THRASHING MACHINES, WEIGHT, AND POWER REQUIRED TO DRIVE.

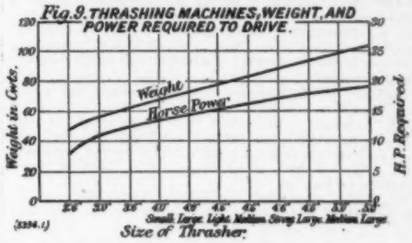
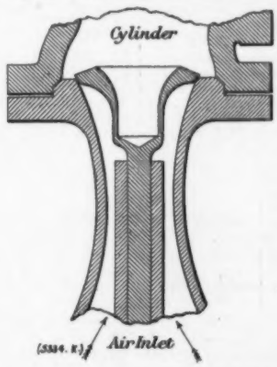


Fig. 10. PARAFFIN VAPOURISER.



in obtaining the fuel, paraffin being probably the most universally and readily obtainable of all oil fuels. On the other hand, such an engine running on paraffin would probably use up to 30 per cent. less, a very material and important saving, and one which should induce the engineer to persevere with this type : the fact that the automatic ignition of this type removes the risks of all electrical gear must be borne in mind. It should be quite possible, however, to secure better economies with the ordinary engine than are at present customary. It may be taken that the consumption per acre in practice is 3 gallons, often more, sometimes less. A 20-h.p. tractor has probably an average load of not more than five-eights of the maximum, or, say, 12½ brake horse-power (see dynamometer readings—three shares, plus allowance for stoppages and headlands). Taking 2 hours per acre, this gives, say, 12 pints per hour, or 0.96 pint per brake horse-power. This result is not at all a bad one, and is probably much better than what is actually taking place in day to day work when the tractor is run by an ordinary farm hand. It should be possible to cut it down to 0.85 pint per brake horse-power, or with a high-compression engine to 0.6 pint or even less.

The type of engine used, whether vertical or horizontal, would in practice largely depend upon the plant of the manufacturer, four-cylinder vertical engines being naturally adopted by the motor-car engineer, whose factory is suited to that type : where factory considerations do not step in it might very reasonably be claimed that the horizontal type is to be preferred. It has frequently been found in practice with vertical engines not possessing vaporising devices in the engine cylinder, that some of the paraffin fuel passes the pistons and mixes with the lubricating oil in the crank chamber, with a consequent thinning of the lubricant, which causes excessive wear on the main and crank-pin bearings. It is not suggested that there are not many effective paraffin carburettors on the market, but rather that, despite these, with the class of labour available on the farm for operating the tractor, such action will frequently take place in starting up and on light load.

The horizontal engine gets over this difficulty, inasmuch as excess paraffin will drain off through the exhaust valve before reaching the piston. A form of inlet valve which has been very successful is shown in Fig. 10. It will be noted that the hollow head, which is kept hot by the cylinder temperature, is arranged so that the entering gases in passing at a high speed through the venturi will impinge upon the hot walls : this forms an effective and compact vaporiser, and at the same time being in an inverted form, is self-draining. It must not be forgotten that the hot bulb engine can work with tube ignition, thus cutting out the electric installation, which is of all parts of the tractor probably the least understood by the farm hand : incidently, the running cost is reduced, as petrol is not required for starting up. Thus such an engine could be arranged to operate by tube with but trivial alteration, in case of failure of the electric ignition.

The water injection, so often found in the high-speed engine of the vertical type, cannot be said to be con-

* See "Scientific Determination of the Merits of Automobiles," Dr. A. Riedler.

ducive to long life: it was tried years ago in gas-engine practice and eventually dropped.

The vertical quick-running type can be and is manufactured at a less total weight, and this has been an additional reason for its use on light-weight tractors. It is, however, quite reasonable to ask whether, despite our being used to comparatively high-speed engines on motor cars and wagons where the average load is low, and the quality of fuel and the attention good, a speed of 500 r.p.m. can be exceeded under the conditions of farm service, quality of labour, heavy ploughing loads and paraffin fuel, without a more than proportionate risk in wear and tear. Fig. 5 shows diagrammatically the two types of tractor, of which there are, of course, many variations.

Further, it is considered desirable that full power should be obtained with a mean pressure of only about 50 lb. per square inch, and that as in the horizontal type of engine the vapouriser should be in the cylinder head and allow of easy drainage for the use of low-grade fuels. A suitable arrangement has already been described in Fig. 10.

It is quite true that the high speed engine reduces the weight of a tractor, but in view of the necessity of giving a reasonably long life under the conditions of farm usage, it is debatable if this is a wise policy. A comparison with a light-weight tractor on a basis of cylinder capacity indicates that these tractors obtain their light weight per horse-power largely by high engine speed and rating.

Type of Tractor.	Weight. Lb.	B.H.P.	Bore. In.	Stroke. In.	Revs. per Minute.	⅔ Lb. per Sq. In.	⅔ Weight. Tons.	Volume Swept per Minute. Cub. Ft.	Volume Swept per B.H.P. Cub. Ft.	Volume Swept. Weight. Tons.
Four-cylinder vertical light tractor type	3,000	25	4½	5½	900	67	50	340	13.6	254
Two-cylinder horizontal multi-purpose tractor	5,600	28	7½	11	475	48	10	534	19.0	214

Flywheel Effect.—It is very desirable to arrange for ample storage of power in the flywheel of the engine to provide for the momentary excess required when meeting hard places, whereby the engine is subject to less strain, and the fuel consumption should also benefit. In the horizontal type suggested the flywheel effect is sufficient to provide 50 per cent. power increase for about 30 seconds. In the light tractor with a quick-running engine there is usually considerably less power storage in the flywheel and the engine must bear directly the extra demands and shocks.

Cooling.—Two methods are in vogue for cooling the engine—in the one the motor-car system, a radiator, fan and circulating pump are used, and in general the whole conforms very much to the standard practice in this respect. In the other system tank storage is adopted, the cooling of the motor being obtained through the loss of heat, due to evaporation from the open tank (the released latent heat, of course, effecting this).

The tank system is simple and is more fool-proof in its working. It allows of almost any sort of water being used, such as is found in streams and drains about the fields, but on the other hand, it needs considerably more make-up water than does the radiator system. The advantage of the radiator system is the much smaller quantity of water needed, so that if water is scarce the saving in cartage may be considerable. Its disadvantage is that the radiator itself may silt up or in some way develop leaks. Both systems are used and probably local conditions will govern the choice.

Frame.—The older type medium-weight machines employed as a rule a special frame built up of rolled sections, whilst later designs, in order to save weight, have incorporated the frame in the general design of the machine with advantage. This feature should undoubtedly be adopted in the design of a multi-purpose machine.

Gearing.—The typical forms of gearing for the two types of tractors are shown in Fig. 5. In one we have the design based on the motor-car arrangement, using either bevel or worm gears, and with a high reduction on account of the high-speed engines, and in the other the design is based on that of the steam traction engine, in which neither the bevel nor worm is necessary: due to the cross-setting of the engine this type has not usually been totally enclosed. This feature, *i.e.*, the total enclosing of the gearing and the running of the gears in oil baths, which originated in motor-car practice, should undoubtedly be incorporated in the other. As the test detailed in Fig. 7 indicated, the loss in the gearing is high, due probably to the exposed gears, want of alignment under load and insufficient lubrication. When the horizontal engine type is built with all its gearing totally enclosed, the efficiency should be equal to motor-car practice (see Riedler*). As the reduction is less, and as no bevel or worm is employed, it is not unreasonable to expect from the horizontal engine a higher overall efficiency than from the high-speed engine design. The advantages of ball or roller bearings in the reduction of frictional losses are questionable. Published tests indicate but small bearing losses, so that any gain would be trivial.

Steering.—There are two types of steering, the single and double pivot. The one is practically the standard in present agricultural machines, as steam tractors, &c., and the other is the standard in motor-car practice. The first is simple, cheap and strong in principle, and outside agricultural work, it is chiefly used in steam-wagon practice. Yet despite this, there is a general tendency to adopt the double-pivot system for small tractor work, and this system, when centrally mounted so as to give three-point suspension, is to be preferred for the class of tractor under consideration (see Fig. 11).

Wheel Arrangements.—Fig. 12 shows some of the arrangements of the wheels of tractors on the market for each of which the makers claim special advantages.

It is not proposed to enter into an examination of the claims of any particular arrangement as they refer solely to land work and not to the road, their use on which is somewhat in the nature of a by-product. The need for a tractor to be an efficient machine for road work, materially narrows the field of selection, and as long practice has proved that, for the power contemplated, the two-track four-wheel machine is the most suitable, this seems undoubtedly the one to be selected, as such a wheel arrangement is equally effective on the land. The size of wheels may be 3 ft. by 5 in. for front wheels, and 4 ft. by 12 in. for back driving wheels.

It is noticeable that there seems to be a tendency in tractors now coming into use to adopt rather smaller diameter wheels (4 ft.), probably with a view to reduce weight. There are two views as to the value of diameter and width, but it is not proposed to enter into these now. The matter was somewhat extensively gone into in a paper read by Colonel Crompton before this Institution in April, 1913, and in an appendix to the same prepared by Mr. Leslie Hounsfield.*

The caterpillar arrangement, whilst entirely suitable for special conditions on the land, cannot be considered as an advisable type for regular road work, and is therefore not discussed for the dual purpose called for.

In order to stand up to the road work the wheels of the tractor must be specially strong, though this naturally tends to increase of weight. It is true that, to save in the total weight of the tractor, light wheels might be adopted for work on the land, so designed as to be readily replaced by specially strong and heavy ones when the tractor is required to run on the road. In actual practice, however, it is probable that the inconvenience and time taken in changing such wheels, together with their considerable extra first cost, would very much limit, if not ultimately eliminate, any advantage there might be in this proposition, though it has been frequently suggested.

All axles for road locomotion must be mounted on springs, and this can be readily done in the type of tractor adumbrated. A road engine, besides having all its weight sprung and the wheels of extra strong design, must in itself be so designed as to properly take care of the vibration set up by such duties.

Land Grips.—As has been indicated, the projections attached to the rim of the driving wheels to obtain sufficient hold when ploughing, are an important feature, and their design to obtain efficient working is one of no inconsiderable difficulty: the paths traced by three different forms are shown in Fig. 6. The spuds must be of such size and form as to obtain effective hold on the land, and yet not set up too great an increase in rolling resistance by their shape: they should be self-cleaning, and so formed and fitted that, should the differential come into operation and only one wheel revolve, no such side force is set up as may cause the tractor to slip sideways at right angles to its path.

Generally the older forms of tractors, although they gave good service, do not appear to have received sufficient care in their design regarding the points discussed, and they frequently lacked the finished appearance of a complete design due to the apparently haphazard arrangement of the constituent parts, *i.e.*, engine, gears, &c., on a rolled section frame.

Progress in this direction has undoubtedly taken place, as is shown by the light type of tractor now coming on the market, in which a separate frame is obviated, and it is obvious that the design was completed at one time by an engineer trained with an eye to the appearance of the whole. Similar ideas might be incorporated in the horizontal type of engine, with undoubted advantage.

There are very many other questions and points of interest that might well have been discussed, and which the author would have liked to deal with, but the time at his disposal has been too limited to afford adequate treatment. He hopes, however, that sufficient data have been brought forward to start others upon the investigation of the problem of the agricultural power unit and to form the basis of a discussion to-night.

* "Scientific Determination of the Merits of Automobiles."

* An interesting communication has also been received by the secretary from Mr. Amos F. Moyer, of the University of Minnesota, through the Society of Automotive Engineers.

HARBOUR CONSTRUCTION IN MOROCCO.—The contractors for the construction of new harbours at Kennitra and Rabat have obtained sanction for their plans and the necessary concessions from the general Board for Public Works. New harbours will also be built at Pedhola and Casablanca. At the latter place a quay of 698m. in length is being constructed and a breakwater of 262 m. length as a protection for the harbour: the depth of the new harbour will allow of the entrance of vessels with a draught of 10 ft. to 11 ft. 6 in. The new harbour works at Mazagan are progressing satisfactorily, and harbour improvements are also being undertaken at Seffi and Mogador, the western quay of the latter harbour having been extended some 200 m.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Sulphate of Ammonia.—While there is in the meantime no "market" for sulphate of ammonia, the position of the home supply and demand remains on a particularly good footing. The shortage of nitrate of soda, as required for agricultural purposes, has been well met by the increased output of sulphate, and had this not been so, the cultivation of the greatly extended acreage rendered necessary for the production of food supplies which have been practically impossible. Government control has certainly kept the price at a rather low level, the present quotation, wholesale, for spot cash being 15*l.* 5*s.* per ton, with 15*l.* 17*s.* 6*d.* for spring, net cash, delivered at buyer's works, but so long as makers are satisfied with the current rates nothing further need be said on the subject.

Scotch Steel Trade.—While it is neither advisable nor desirable to deal with figures or statistics at the present time, it is no breach of trust to say that the year which has just closed has been the most remarkable in the history of the steel trade in the West of Scotland. If all goes well it is confidently anticipated that even the record output of finished steel will be greatly increased during the next few months, when all the extensions and improvements at present under way shall have been completed. It is computed that the increase should total some 50 per cent. to 60 per cent. in advance of the pre-war production, a feature of some very considerable importance when viewed in the light of the home and export trade and commerce after the war. The last week of the year was a particularly busy one, and it is interesting to note that the efforts to get as much work as possible turned out before shutting down for the holidays were eminently successful. No general resumption of activity will take place before Monday, although repair squads will be busily employed in most of the steelmaking establishments. After the holidays the claims of the shipbuilders will receive additional attention if it be possible for them to secure more labour—scarcity of labour being, at the moment, the only drawback to their operations. Prices remain at the level current now for some time, ship plates, 11*l.* 10*s.* per ton: boiler plates, 12*l.* 10*s.*: and angles, 11*l.* 2*s.* 6*d.*, all net per ton, f.o.t.

Malleable Iron Trade.—Up till the close of the malleable iron works on Saturday the greatest activity prevailed everywhere, the desire in each establishment being to turn out as much as possible of the accumulated arrears before the holidays. As matters stand at the moment the entire output is earmarked for the purposes of the war, and less than ever is now available for export, much as this is to be deprecated for various reasons. The demands of Government, however, are of paramount importance, and all other consumers must stand aside. Prices continue firm.

Scotch Pig-Iron Trade.—The activity in the pig-iron trade continues, and evidences are not wanting to prove that, during 1917, the output has reached a level never touched hitherto, and, the holidays notwithstanding, so great is the demand and so short the supply that the furnaces will know no respite, but continue to work as usual. Hematite is especially scarce, and everything produced is speedily absorbed by the local steel-making establishments. Opportunity is to be taken of the general cessation of business to execute some necessary repairs, but some little difficulty may be experienced owing to a demand for an advance being made by the bricklayers. Of course, if this can be amicably settled, the work may be proceeded with at once. Although little export is being put through, rates are strong, but home prices remain unchanged.

The New Year Holidays.—Much satisfaction has been expressed locally at a full week's holiday having been granted at this time with the consent and approval of the Admiralty and the Ministry of Munitions. Not only the workers, whose labours have been constant and strenuous, but the machinery and plant require rehabilitation also, and all will go on better after the well-earned cessation of activity. So far as possible, repair gangs will be on duty during the week endeavouring to make up for the wear and tear on machinery, &c., caused by the incessant strain of the past five or six months.

Interesting Alliance at Dumbarton.—Intimation has just been made of the prospective amalgamation of two important concerns in Dumbarton, the shipbuilding yard owned by Messrs. William Denny and Brothers, and the engineering works of Messrs. Denny and Co. The intention is to float the two as a private limited company, under the designation of William Denny and Brothers, Limited, with, of course, the present partners as directors, while the name of Engineer-Commander W. M. Wisnom has been mentioned as an addition to the governing body. Dumbarton owes much of its prosperity during the past fifty years or so to the energy, business acumen and public-spiritedness of the famous Denny family.

PRICE OF CALCIUM CARBIDE.—It is officially announced that the wholesale price of calcium carbide is reduced to 35*l.* per ton, as from the 1st inst. This price, however, is subject to alteration at any time, as may be directed by the Minister of Munitions.

PERSONAL.—Mr. H. M. Thornton, M.I.M.E., the managing director of the Richmond Gas Stove and Meter Company, Limited, furnace and industrial engineer has been elected an associate of the Institution of Civil Engineers.—Mr. E. Ulrich has severed his connection with Messrs. Bolling and Lowe, 2, Laurence Pountney Hill, E.C., 4, as from August 31, and has commenced business at 19, Bishopsgate, E.C. 2.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

The National Electricity Scheme.—Considerable interest has been taken in Sheffield in the suggestion of the Coal Conservation Committee for the establishment of 16 "super-power" electric stations from which to supply all the country's power for industrial and other purposes. Generally speaking the scheme does not meet with the same approval in the large inland industrial centres as in coastal districts where the proximity of tidal waters obviates the necessity of erecting cooling stations and thereby lessens the cost of production. Sheffield, it is pointed out, is at present hugely expanding its electricity system to meet the great industrial demand. Since the war the demand made upon the electrical supply department of the city is ten times greater than in pre-war days, and all indications point to that progress being maintained after the cessation of hostilities. To meet the progress of the near future and have a reserve for developments, Sheffield is erecting a new station capable of producing over 100,000 kw., which, with the existing plant, will give a supply of over 168,000 kw.

Iron and Steel.—A review of the year's progress in the iron and steel industries shows that Sheffield manufacturers are fully alive to the necessity of throwing off that inertness and indifference which at one time threatened our national trade supremacy. The cutting-off of the vast Continental supplies of lower-grade steel material has rendered necessary the task of doubling or trebling the home make of basic steel, and notwithstanding the diversion of labour and plant to war work, a very few months should see this accomplished. Already more than a score of basic furnaces of the largest capacity have been erected in or around the city, and when all the extensions have been completed, Sheffield district will more than double its pre-war capacity, by being in a position to turn out 1,500,000 tons of open-hearth steel annually. Of even greater significance, in that it is a radical departure from old traditions, has been the remarkable development of melting steel by electricity, which is seriously attacking the old crucible process, in which Sheffield stands pre-eminent. The electric furnaces already installed in the city will add some 50,000 tons per annum to the aggregate local output of high-grade steel. Vast additions to plant have also been made for the production of hard steel rods. Prior to the war the importation of these averaged some 30,000 tons per annum. The erection of large mills equipped with the latest improvements for rapid and economical production, will do much to meet the requirements of the wire trade. The general rolling capacity of the city has also been recently substantially increased by the addition of mills driven by electricity and gas power. Broadly speaking, the work of the past year can be looked upon with satisfaction by all interested in the welfare of the city.

South Yorkshire Coal Trade.—The past has been a holiday week. The output has been comparatively small, but opportunity has been taken to effect repairs and renewals to plant which should have a marked effect on the production in the early part of 1918. Early in the past year delays to traffic were frequent and serious, but later an improvement was effected, and for some months traffic has worked remarkably well. The call for all descriptions of steam fuel has been exceptionally active. Not only have the requirements of home manufacturers engaged on the production of war material enormously increased, but the demands at the Humber ports on Government account, and for export to France and Italy, have always been in excess of the supply. Prices under control, with the exception of the 2*s.* 6*d.* advance in September, have shown little variation. In gas fuel the markets have been very strong, owing to the large increased requirements for industrial use. For all descriptions of slacks the demand has always exceeded the production. Coke, too, has been in brisk request, and prices have been substantially advanced during the year. In house coal there has been a scarcity all through the year. The Household Coal Distribution Order, which came into force at the beginning of October, and the Retail Coal Prices Order, have had some effect in ameliorating the hardships on consumers, but the position is by no means satisfactory.

TRADING WITH THE ENEMY ACT.—The Controller of the Foreign Trade Department has sent us a copy of a new list (No. 42) of additions to the Statutory List of firms of enemy nationality or enemy association with whom persons in the United Kingdom are forbidden to trade. Copies of this list can be obtained at a trifling cost from the Superintendent of Publications, H.M. Stationery Office, Imperial House, Kingsway, W.C.

THE LATE MR. GEORGE SMITH.—We regret to have to record the death of Mr. George Smith, J.P., C.A., senior managing director of the Smith and Grace Screw Boss Pulley Company, Limited, which occurred on December 17, at his residence, The Hollies, Thrapston. Mr. Smith was born at Stamford in 1841. He was a son of Mr. Nathaniel Smith, a pioneer in the agricultural implement trade. The deceased and his brother, Mr. Edwin Smith, acquired, forty-eight years ago, the interest of Mr. Grace in the well-known business of Smith and Grace, agricultural engineers, Thrapston. Some thirty years after this, the business having in the meantime changed its output from agricultural implements to power transmission appliances, the present private limited company was formed, Mr. George Smith and his brother being joint managing directors. For the last forty years he devoted much time to public life and carried out his duties indefatigably and in a most thorough manner.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—With holiday making general, it is not easy to ascertain anything new concerning the iron trade. 'Change, for the time being, is practically deserted. Home quotations for Cleveland pig-iron are the same as a week ago, but export rates have been reduced by 2*s.* 6*d.* per ton. Thus for home consumption No. 3 Cleveland pig-iron, No. 4 foundry and No. 4 forge all stand at 95*s.*, and for shipment to France and to Italy these qualities are quoted 114*s.*

Hematite Iron.—There appears to be no new feature of importance in the East Coast hematite department. Conditions continue stringent, but as production of basic iron is being steadily increased, relief should be experienced at an early date. Exports keep only small, but deliveries to home customers are maintained on a scale sufficient to satisfy minimum requirements. Mixed Nos. are 122*s.* 6*d.* for home use, and 147*s.* 6*d.* for export to France and Italy.

Coke.—Supply of coke is ample. Local demand is considerable, and a good deal of business is passing. For home use average blast-furnace kinds are 33*s.* at the ovens, and qualities low in phosphorus 35*s.* 6*d.* at the ovens: whilst foundry coke is 38*s.* For export to neutrals both beehive and patent oven coke are put at 45*s.* f.o.b., but these descriptions are understood to be obtainable at 42*s.* 6*d.* for shipment to Allied ports. Gashouse coke is in good demand for export at 39*s.*

Manufactured Iron and Steel.—Producers of manufactured iron and steel are full of orders for the Government and for the shipyards, and few firms are in a position to entertain offers of ordinary commercial business. Substantial inquiries for steel rails are reported, but little actual business results, and deliveries against running contracts are stated to be very irregular and inadequate. Much-needed repairs and renewals &c., to plant have been effected whilst works have been closed down for the Christmas holidays. Quotations, all round, keep very firm. For home use common iron bars are 13*l.* 15*s.*: best bars, 14*l.* 2*s.* 6*d.*: best best bars, 14*l.* 10*s.*: iron ship plates, 15*l.* 10*s.*: iron ship angles, 13*l.* 15*s.*: packing iron and steel (parallel), 13*l.* 10*s.*: packing iron and steel (tapered), 15*l.* 15*s.*: steel bars (no test), 14*l.* 10*s.*: steel ship plates, 11*l.* 10*s.*: steel ship angles, 11*l.* 2*s.* 6*d.*: steel boiler plates, 12*l.* 10*s.*: steel joists, 11*l.* 2*s.* 6*d.*: and heavy steel rails, 10*l.* 17*s.* 6*d.*

Shipments of Iron and Steel.—Shipments of iron and steel from the port of Middlesbrough last month were the smallest since the commencement of the war. Pig-iron loadings amounted to 27,270 tons, which was higher than November figure when only 23,638 tons were despatched, but is a drop on the October clearances, which were returned at 29,412 tons. December shipments of manufactured iron were 1,547 tons, and clearances of steel 8,133 tons, a total of 9,680 tons, as compared with 16,308 tons in November and 31,365 tons in October. Thus the aggregate shipments last month of pig-iron, manufactured iron and steel amounted to 36,950 tons, or 2,996 tons less than the previous month, and 23,827 tons below the total clearances for October.

TAR.—The Minister of Munitions has issued an Order dealing with tar produced or derived from the destructive distillation of bituminous material by any means other than blast-furnaces, and with water-gas tar produced by carburetting water-gas. As on and from the 15th inst. until further notice no person manufacturing or producing the said tars shall burn or consume them for firing, steam raising, or heating purposes, nor use them for any other purpose except under and in accordance with the terms and conditions of a licence issued by or under the authority of the Minister of Munitions. Provided that no such licence shall be required by a manufacturer or producer of tar who is also a tar distiller to entitle him to distil to pitch all or any of the tar manufactured or produced by him. The Order of the Minister of Munitions dated September 4, 1917, relating to coal tar is now cancelled under certain conditions stated in the new Order.

SPECIAL ENTRY NAVAL CADETSHIPS.—There are still a limited number of vacancies for Special Entry Naval Cadets to join the Royal Naval College, Keyham, this month. It appears from the recently-published list giving the result of the examination for entry into the Royal Military Academy, Woolwich, that some of the candidates for Woolwich, owing to the limited number of vacancies, have failed to obtain admission, although they obtained qualifying marks. The Admiralty have therefore decided that any such candidate for Woolwich who obtained qualifying marks but who has failed to obtain a Military Cadetship, may apply at once by letter to the Secretary of the Admiralty, Whitehall, S.W. 1, to be considered for a Special Entry Naval Cadetship. Such candidates must have been between 17½ and 18½ years of age on September 1, 1917, and would not be required to take a further literary examination. They would be required, however, to attend at the Admiralty for an interview, and, if accepted, to undergo a medical examination by the naval medical authorities. If accepted after interview and found medically fit, all such candidates would proceed to the Royal Naval College, Keyham, at the beginning of the next term, which commences on the 25th inst. Applications should be addressed to the Secretary of the Admiralty at the earliest possible moment, when further instructions will be issued to each candidate.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Markets.—Holiday conditions still prevail on the coal markets, and these conditions are likely to continue until next week. The result is that there is even less than usual to report this week. The market has not yet been informed of the arrangements made in regard to the regulation of prices at the port of loading of pitwood, but the Order of the Controller fixing 65*s.* as the ex-ship price at Cardiff has already taken effect, and cargoes have been sold at this price during the last day or two. The holidays afforded an opportunity of effecting clearances, but the released wagons have now been practically exhausted, and intermittent stoppages at the collieries are expected, if not this week, almost certainly next week.

Newport.—Stagnant conditions continue to govern the market for Newport coals. There is a good inland demand, and pressure is being brought to bear on the Great Western Railway Company to return empty wagons from the South-Western Counties in accordance with the arrangement made with the Controller of Coal Mines and the Railway Executive last September. The railway company, apparently, have not been able to observe the agreement. At any rate it is suggested that the agreement has been disregarded on more than one occasion, and it is hardly likely that, if that is so, the colliery owners will consent to send their own wagons long distances unless their prompt return is assured.

Short Time at the Collieries.—Another meeting of the Commission of Inquiry into the question of lost working time in the coalfield was held on New Year's day, but the proceedings were private. The Coal Controller has considered the report already submitted to him by the Commission, but no steps have yet been taken with the view of mitigating the evils of irregular working: and it is questionable whether the difficulties which present themselves can, in the present circumstances, be surmounted.

ENGINEERING APPRENTICES AND EVENING CLASSES.—Recognising how important it is that technical education should be fostered, Messrs. J. Stone and Co., Limited, of Deptford, S.E., are encouraging the boys employed in their works to take full advantage of the valuable facilities afforded by the evening classes of the L.C.C. and other institutions in the neighbourhood. Prizes will be awarded on the results of the class work and, to induce those who were not already attending such classes to take advantage of the scheme and begin their technical training at once, the company is paying the fees of a number of boys for whom three new special classes are now being opened. The L.C.C. officials have very readily undertaken the organisation and tuition for these special classes, and it is hoped that the encouragement given the boys (over a hundred are affected by the scheme) will have permanently good results.

GAS-CONTAINER TRAILERS.—The Commercial Motor Users' Association recently represented to the Local Government Board the expediency of allowing the legal speed of a commercial motor vehicle when drawing a trailer used only to carry a gas container, to be such as if no trailer was drawn, in order that the use of coal-gas should be encouraged with a view to securing greater economy in the consumption of petrol. The association has now been officially notified by the Board that the regulations at present governing the use of trailers have been relaxed by the issue of a new Order. Such trailers are now legal without a sacrifice of the speeds respectively applicable to the commercial motor which draws them, provided the unladen weight of the trailer does not exceed 15 cwt., and that all its wheels are fitted with pneumatic or solid rubber tyres. The containers may be of the gas-bag or any other type. The association will shortly be issuing its first list of over 1,000 gas-charging stations throughout the United Kingdom in the form of a 32-page booklet, and a copy will be posted gratis to any user on application to Mr. Frederick G. Bristow, F.C.I.S., Secretary, the Commercial Motor Users' Association, 88, Pall Mall, S.W. 1.

THE EKENBERG PEAT PROCESS.—Experiments on the treatment of peat by a modified Ekenberg process are being conducted at Châteauneuf, in the Département Ille-et-Vilaine, Bretagne, France. According to a paper, published in the *Comptes Rendus* of September 3, and October 1 (errata), 1917, by C. Galaine, C. Lenorm and C. Houlbert, the peat is first compressed in presses of the Mabille or Aurep types to reduce the water in the peat from about 90 per cent. to 60 per cent.: the peat is then treated with superheated steam at 160 deg. C. for 25 minutes, and then either compressed again or at once dried, which is best done in special chambers, though air-drying may be applied. The product, which is called tourbon, still contains from 20 per cent. to 25 per cent. of moisture, but does not absorb moisture, as it would do if the cellulose in the peat had not been destroyed by the steam heat. The calorific value is stated to be raised by 10 per cent. over that of dried peat: the tourbon yields 61 per cent. of volatile matter, 36 per cent. of fixed carbon, and 3 per cent. of ashes. With suitable arrangement of the batteries of autoclaves and utilisation of exhaust steam, a heat efficiency of from 85 per cent. to 91 per cent. is claimed to be realised in this process, which can be worked throughout the year. The tourbon is fired directly, or sent to gas works (with ammonia recovery), or converted into power gas for internal-combustion engines: the last-mentioned utilisation has so far proved most satisfactory elsewhere, we believe.

TESTING MACHINES FOR USE IN AEROPLANE MANUFACTURE.

CONSTRUCTED BY MESSRS. W. AND T. AVERY, LIMITED, ENGINEERS, BIRMINGHAM.

(*For Description, see Page* 1.)

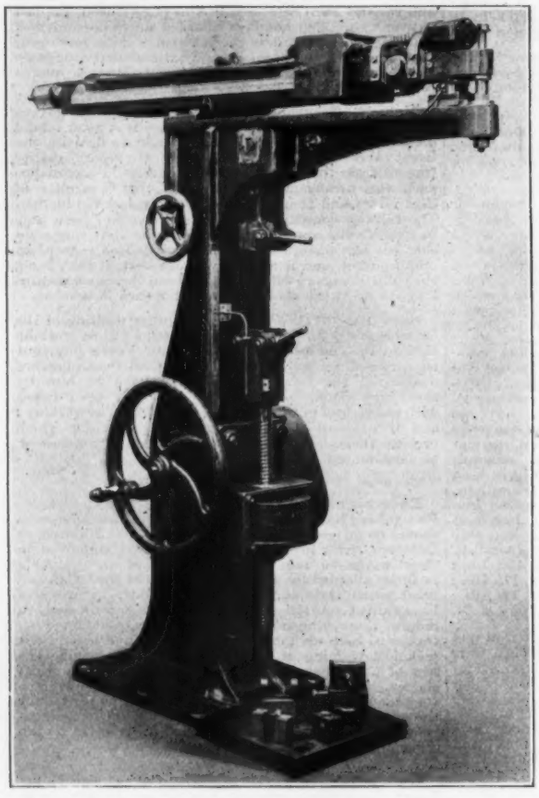


FIG. 15. 6,000-LB. WIRE TESTING MACHINE.

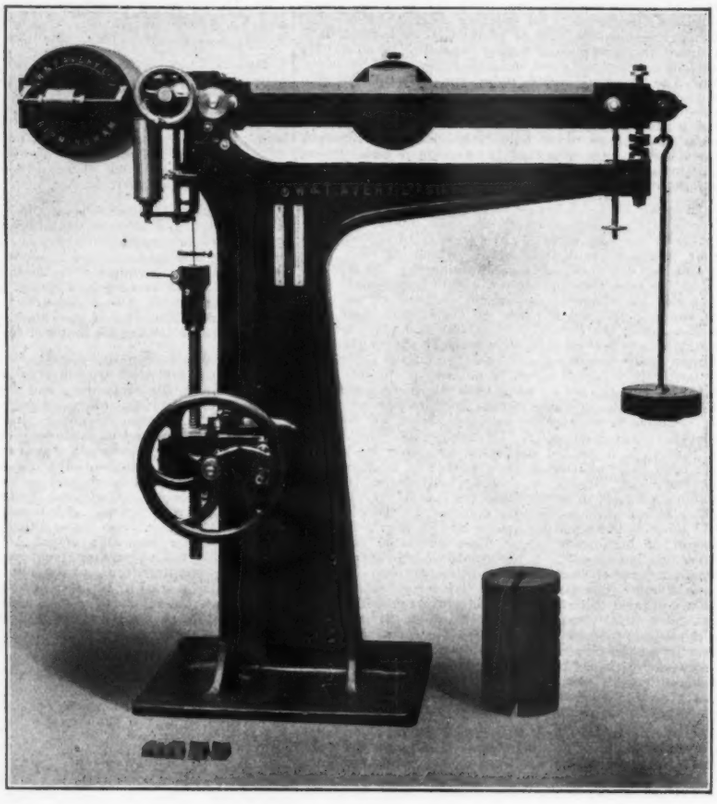


FIG. 16. 10,000-LB. TESTING MACHINE.

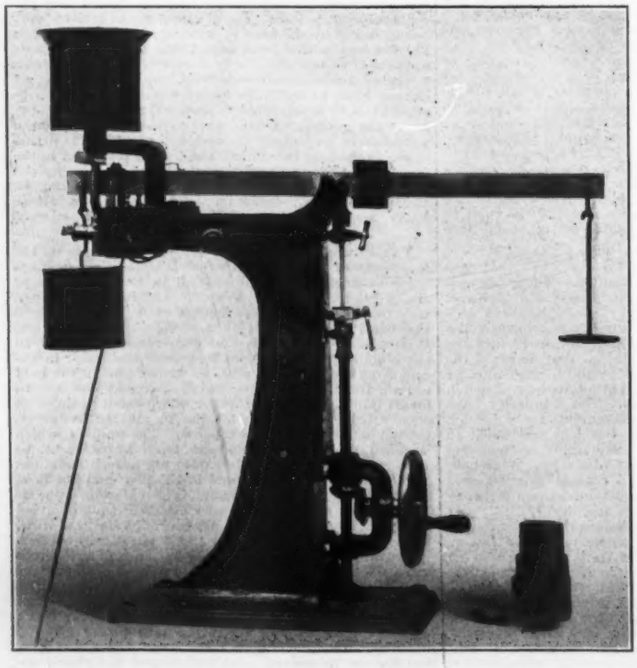


FIG. 17. FABRIC TESTING MACHINE.

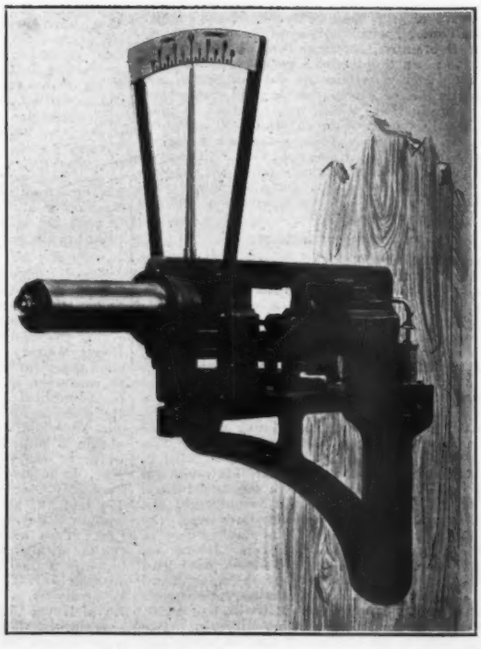


FIG. 18. PROPELLER BALANCER.

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UNITED STATES: For Subscriptions, New York: W. H. Wiley, 432, Fourth Avenue. Chicago: H. V. Holmes, 957-958, Monadnock Block.
For Advertisements, J. S. Allan, 508, Stratford Avenue, Bridgeport, Conn., U.S.A.

ADVERTISEMENT RATES.

The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

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"ENGINEERING" may be ordered from any Newsagent in town or country and at railway book-stalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

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Thick ,, ,,	£2	5	0
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All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "Union of London and Smith's Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C. 2.

Offices for Publication and Advertisements, 35 and 36, Bedford-street, Strand, London, W.C. 2.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3663 and 8308 GERRARD.

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NOTICES OF MEETINGS.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, January 4, at 8 p.m., at 39, Victoria Street, Westminster, S.W. 1. "Some Aspects of Lubrication," by Mr. H. E. Cosgreave.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, January 8, at 5.30 p.m. A statement in commemoration of the founding of the Institution on January 2, 1818. Papers to be submitted for discussion:—"Rail Creep," by Mr. Frank Reeves, M.Inst.C.E., and "Creep of Rails," by Mr. Harry Powell Miles, M.Inst.C.E. And ballot for new members.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Wednesday, January 9, at 8 p.m., at the Royal Society of Arts, John Street, Adelphi, W.C. Professor Groom will read a paper entitled "The Artificial Seasoning of Wood."

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—Wednesday, January 9, at 8 p.m., at St. Bride's Institute, Bride Lane, Fleet Street, E.C. A paper will be read by Mr. A. Ramsey, on "The Human Factor in Modern Production." Mr. H. S. Hele-Shaw, D.Sc., LL.D., F.R.S., in the chair.

THE LIVERPOOL ENGINEERING SOCIETY.—Wednesday, January 9, at 8 p.m., at the Royal Institution, Colquitt Street, when a paper will be read by Mr. James B. Wilkie, M.I.Mech.E., M.I.N.A., entitled "Refrigerator Installations for Carriage of Ships' Provisions."

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, January 10, at 6 p.m., at the Institution of Civil Engineers, Great George Street, Westminster, S.W. "Electrical Signalling and Control on Railways," by Mr. C. M. Jacobs.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN: NEWCASTLE BRANCH; TECHNICAL SECTION.—Friday, January 11, at 7.30 p.m., at Connaught Hall, Newcastle-on-Tyne. A paper will be read by Messrs. J. Steele and T. Larkin, on "Determination of Ship Proportions and Machinery Dimensions."

THE ROYAL SANITARY INSTITUTE.—Friday and Saturday, January 11 and 12, at 7 p.m. and 10 a.m., in the Council Chamber, Town Hall, Chester. Discussions will take place on Friday, January 11, at 7 p.m., on "The Present Position with regard to Venereal Diseases; will the Methods now Available for Combating them be Sufficient?" to be opened by Mr. T. W. Naylor Barlow, M.R.C.S., D.P.H. (M.O.H., Wallasey). Saturday, January 12, at 10.30 a.m., on "Activated Sludge," to be opened by Mr. Meredith Young, M.D., D.P.H. (County M.O.H., Cheshire C.C.), and Mr. S. Ernest Melling, F.I.C., F.C.S. (County Analyst, Cheshire C.C.).

THE LONDON ASSOCIATION OF FOREMEN ENGINEERS.—Saturday, January 12, at 7 p.m., at Cannon Street Hotel, London, E.C. Presidential Address by Mr. R. M. Campbell, M.I. Mech.E., A.M.I.E.E.

THE ASSOCIATION OF MINING ELECTRICAL ENGINEERS: WEST OF SCOTLAND BRANCH.—Saturday, January 12, at 4 p.m., at the Royal Technical College, George Street, Glasgow, when a paper will be read by Mr. J. H. C. Brooking, on "Cable Complaints." A display of cable joint boxes will follow, also a demonstration of repairing of cab tyre trailing cable.

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase dated from and included the issue of Friday, March 16. The change will not apply to unexpired subscriptions.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, JANUARY 4, 1918.

STANDARD AERO-ENGINE PRODUCTION.

MORE than two months ago we raised the questions whether the production of aero-engines was equal to the needs of the situation and the programme laid down; whether the variety of designs that had been encouraged with a view to technical improvement had been reduced with a view to intensive manufacture to the minimum that the needs of the services required; whether variant methods of manufacture had been eliminated in favour of the best and readiest; and whether woman-power was at last being used without restriction on all work to which it could be applied. A month ago we urged again that the production of aircraft in the necessary quantity depends essentially on reducing the types of engines under manufacture to the fewest that will serve, and adopting as standards for war purposes not only the best designs but also the best methods of manufacture.

Events have been moving rapidly of late. They have provoked a crisis in the demand for men, which emphasises the urgency of the right utilisation of woman-power. The Air Council that has been formed to co-ordinate the needs of the air services has transferred the control of production to the Ministry of Munitions. The importance of aircraft in the war by land, on sea, and below water has again been widely proclaimed. This week it is announced that the French Air Board came silently into being some three weeks ago. Its head is the Minister for Armaments, and it was engaged nightly for the first fortnight on speeding-up the construction of machines, in addition to reorganising the services. It is now meeting three times a week, and putting into immediate execution, so far as its resources allow, the demands of General Headquarters for aircraft. Our American allies, as has been known for some time, using the onlooker's advantage of having seen the most of the game, and unencumbered by programmes already in progress, have attacked the problem from the outset with the closest possible standardisation and the fewest possible types. The Germans, again, so far as can be judged from the many machines that have come into our possession, have long abandoned the bulk manufacture of variant types, and have settled down to the production of a very few standards, mostly on the racing-car lines for which pre-war experience was available.

Yet up to now no sign has been vouchsafed to engineers and the country that we have learned either from our friends or our enemies, and that our manufacturing resources, which at the best cannot produce too much for our needs, are to be used at their best. No hint has been given that the flying branches of the air service have been asked to formulate what they require from aero-engines for the several duties they have to undertake; that some man, known and trusted by automobile engineers, has been commissioned, either alone or with an Advisory Committee, to weigh these requirements and select the standard engines that will best satisfy them; that a staff of practical works managers is considering the manifold variations of manufacturing practice, and selecting for general adoption in the manufacture of all aero-engines the methods that have proved themselves to be the most efficient. These would be drastic measures to advocate in times of peace; but the evolution of the aero-engine industry is of secondary importance to the present production of aero-engines. While doubtless one or two experimental factories should be retained, in which variant designs may be studied and prepared for introduction into bulk manufacture when the substitution has been shown to be desirable, the maximum output of the aero-engines required for present warfare will continue to be impossible until it is conducted on standard lines.

It has been suggested that the same need for standardisation for war purposes exists in most other branches of manufacture, and that it could be best supplied by instituting a Board of War Standards of Production, of which the sole function should be to assure the institution and maintenance of war standards for design, methods, material and labour. It is urged in support of this proposal that the absence of such standards is causing enormous waste of resources, and that this waste calls for effective control even more urgently than the waste of money for which the control of the Treasury is admittedly needful. On these propositions no two opinions are possible. Waste of resources in the production of munitions involves, indeed, waste of money; but it involves with equal certainty the graver waste of soldiers' lives and national safety. Yet the proposal to control waste that is attributed to the incoordination of many Government departments and thousands of works by setting up yet another Government department, apart from the obvious objection to trying to drive out the devil by employing Beelzebub, is a counsel of desperation. It is commendable only if the existing departments can themselves agree on no single view of the urgent problems that are before them, or if they cannot settle on a single policy, and execute it with inflexible determination. It would, indeed, be lamentable if this were the case; but we express no opinion on the merits of this proposal in regard to industry in general when we say that it ought to be unnecessary, and therefore undesirable, in the production of aero-engines.

For the actual complexity and comparative novelty of an aero-engine and its accessories makes the selection of designs more dependent for the

time being than other classes of constructions on ascertained practice, just as the multiplicity of its parts makes an exceptional call for the use of the best methods of manufacture. A great volume of practice is already available in the experience of those who were concerned in making internal-combustion engines long before a practice of aviation had been created. It is not a complete aero-engine practice; but it is the basis of the aero-engine practice or practices developed during the war, and the best available body of information for criticising and co-ordinating the construction of aero-engines. A safe decision in the selection of aero-engine designs cannot be made without taking account of the older practice; and now, when the works in which these engines and their accessories and spares are made must be regarded as a single establishment working for a single air service, the smallest possible number of designs must be selected for manufacture if the maximum output is to be attained. The Production Department that now serves the Air Council in the Ministry of Munitions should surely be able to realise for itself that this selection of designs is necessary. It must also know that a single policy cannot be defined with the prospect either of yielding the best result or of commanding the widest confidence unless it has been formulated or approved in the light of the best available knowledge of internal-combustion engine practice; and it should not need the interposition of another department to persuade it that this indispensable condition cannot be assured unless the material to be considered has been weighed by some man or small body of men having the necessary familiarity with this practice. At present the service is far from enjoying the benefit of any such selection. We are credibly informed that over 40 different types of aero-engines are now being manufactured in this country, and about as many firms engaged in their manufacture. The labour absorbed in the extravagant multiplication of tools, jigs, gauges, drawings and patterns, regrettable though it is, does not end the burden on the air service through this variety of designs. The effect, for instance, on the stocks of spares may easily be imagined; and, as we understand, the engines are so different in construction that aerodromes at the front not only require separate spares for the several types that are used there, but have also to keep for purposes of overhaul separate gangs of mechanics, versed in their individual peculiarities.

The question of manufacture stands on a similar footing. Intensive production is not quite the same thing as general engineering manufacture. The differences may be slight; but when they are multiplied by the number of parts to be produced and assembled, they show a wide difference in efficiency between the best methods and those that are passable, to say nothing of those that are frankly bad. The actual slightness of these differences makes the more urgent call for men who are known to be practically and successfully familiar with methods of intensive production to select the methods for making aero-engines, if they are to be produced at the necessary speed; and this speed should be nothing short of the highest at which they can be turned out.

The Production Department, if it uses its position firmly and consistently, is well placed for attaining this necessary result in that it has behind it the vast powers of the Ministry of Munitions. But, to speak with the plainness that the present critical situation demands, the particulars that have been published of its constitution do not satisfy engineers that it is in a position to use this advantage. A firm and consistent policy in the choice alike of designs and of methods of manufacture cannot be expected, and would not readily command confidence, unless it was evolved or endorsed by men of the special experience to which we have referred. So far as is known, the department does not include men on its staff who would be accepted by engineers generally as able to speak with the necessary first-hand knowledge and authority on either the design of internal-combustion engines or the methods of intensive manufacture. More than this indispensable knowledge and authority is doubtless necessary to secure a general acceptance of the methods that it would prescribe; and engineers may look with confidence to Sir William Weir to provide the weight and engineering insight that would be required for the purpose. But while the Production Department lacks this specialised knowledge and authority, which in the present critical emergency should be the very highest that is attainable, even the great abilities of the Director-General and the respect in which he is universally held will be insufficient. The present chaotic and indecisive state of aero-engine production is to a large extent the mere expression of this absence of technical authority in those who control it. To express its ultimate consequences in terms of lives or money would be superfluous in a war that already is known to be costing us thousands of casualties and millions of money for each day by which it is prolonged. Such calculations are not the business of engineers, and it is not for them to determine whether, if the supply of aircraft is only a fraction of what it might be, the ultimate issue of the war is being jeopardised. Their duty is to produce the engines; and what we are here concerned to say plainly and without reservation is that, while the machinery for controlling manufacture remains as it appears to be, it is preventing them from discharging that duty.

ELECTRIC POWER SUPPLY.

IT may safely be said that the Report* to the Reconstruction Committee on Electric Power Supply in Great Britain would never have been issued to the public in pre-war days. Either the committee would have been packed with politicians in order to ensure the suppression of facts inconvenient to a certain school of economics, or had it by some inadvertence been constituted of experts, only a carefully edited summary would have been generally accessible. Politicians generally have little liking for letting the public know more than is good for it. The resentment aroused in a certain section of the London County Council at the independent expert evidence rendered by the police with reference to certain tramway schemes found strong expression, the standpoint taken being that the police should submit their views to the Council, who would then have the option of deciding whether or no publication were desirable.

The whole of the report on electric supply from first to last is an indictment of the policy pursued in the past, and it is most improbable that it would have been deemed expedient in pre-war days to publish so frank an exposure of the mistaken views so long prevalent with politician economists.

A popular cry twenty years or so ago was "Save London from the Trusts," and as a result the community was saddled, apparently in perpetuity, with an inefficient and unprofitable system of internal transport. Similarly, Lancashire was saved from an electric trust by the establishment of innumerable municipal power stations, and the results are laid patent in a recent official report. Industrial activity is greater in Lancashire than in any other part of the world of equal area. The conditions were therefore eminently favourable to electric power supply, coal being cheap and the load good. Actually the average cost of electric power as supplied in this area is nearly three times as great as in the much less favourable area served by the North-East Coast Power Companies, much of which has but a scanty population. The average price in Lancashire appears from the report to be about 1¼*d.* per unit as against the average of less than ¼*d.* demanded by the "Trust." Moreover, the amount of current used per head is three times as much on the North-East Coast as in the Lancashire area. Nor do the disabilities attaching to the policy pursued in Lancashire cease here. Every year that passes increases the amount and value of the plant which it will be necessary to scrap in order to effect the revolution in the system of supply which cannot be indefinitely postponed. In the North-East Coast area, on the other hand, further extension will be merely a natural development of the existing state of affairs.

London is in about as bad a plight as Lancashire. In the central area there were, in 1913, no less than 39 electric supply authorities, and in Greater London 70. With the exception of Lots-road, hardly one of the power stations is so situated as to have an ample supply of condensing water or of such a size as permit of the highest efficiency in the plant equipment. Most of the stations, in fact, have to employ cooling towers, which imply not merely a low vacuum with its consequent high steam consumption and waste of fuel, but also necessitates the frequent cleaning of the condenser tubes, if their resistance to the transmission of heat is to be kept within reasonable limits. The average size of the station in the Greater London area is 5,285 kw., which is only about one-quarter of the smallest single generator considered desirable in the "super" stations recommended in the report.

Similar conditions obtain throughout most of the country. Stations rule small in size and are badly placed. A determining factor in many cases has been the desire to keep the station within borough boundaries so as to avoid paying rates on the works to some outside authority!

As the comparison made between the North-East Coast area and Lancashire shows, the net result of municipal electric power stations has been that the cost of electricity throughout the country has been in the past something like three times as much as it should be, and unless revolutionary changes are made the overcharge will tend to increase rather than diminish. Less was known as to the advantages of large scale working. when the Kitson Committee sat in 1900, but even then it was evident that small local stations were ineffective, the evidence to this effect being too strong to be ignored. The committee, however, got over the difficulty very cleverly from their own point of view, by introducing into the bills on which they reported, clauses which would appear to have been carefully designed to prevent the successful establishment of power plants serving the needs of large areas. In the first place the large towns were excluded from the operation of the Acts, and in the second place, whilst it was provided that a power company might supply a customer within areas served by a local authority, this could only be done with the consent of that authority. This consent, it was true, could not "be unreasonably withheld," but the astute politicians responsible for the clause knew well that when a customer wanted power he generally wanted it at once, and would not readily face long protracted negotiations as to the reasonableness or the reverse of his demand.

Again, fresh consent had to be obtained for each additional new customer, so that one alone might have to bear the capital charges involved in bringing the company's main into the town. There was still another resource open to the local authority, viz., to make relatively low charges to private consumers and to restore the financial status of their undertaking by making heavy charges for supplies for public lighting or traction. Thus at Accrington private consumers pay an average of 1.12*d.* per unit, whilst the tramway undertaking is charged 1.75*d.* per unit, and the public lighting department 2.59*d.* As the report states, a case might perhaps be made out for subsidising the private consumer in order to develop the use and supply of electricity on the right lines, but the effect has been in actual fact to perpetuate the existence of an uneconomical and inefficient method of utilising our fuel supplies.

It is absolutely essential that our industrial efficiency shall be greatly increased in the future if a serious reduction of the general standard of existence is to be avoided. Such a decline will of course affect most of those who have had in the past the smallest margin to the good. One effective means towards this end is to increase very largely our present use of power, which is less than two-thirds the amount used in the United States per head employed. It is this greater use of power which is largely responsible for the fact that the standard of wages is higher in the States and living conditions better, though another important factor is, of course, their more economical use of skilled workmen.

In spite of the demand of the trades unions for the restoration of pre-war conditions, it is exceedingly unlikely that the old rates of wages will be reverted to and though there will, it may be hoped,

* Interim Report on Electric Power Supply in Great Britain, Cd. 8880. Price 3d. net.

be some reduction in present coal prices, much of the recent increase will also be permanent. Cheap supplies of power will therefore be practicable only if advantage is taken of every known method of economising fuel and reducing generating costs. Prophecy is, no doubt, a dangerous indulgence. When the public supply of power gas was arranged for in Staffordshire the promoters of the Bill based their expectations of profit on the supply of gas for power production, only to find that the introduction of the suction gas producer had radically changed for the worse the price which it was practicable to charge for gas supplied for use in engines. In spite of this precedent, however, there is, we think, little risk in affirming that the days of individual power plants are numbered. Threatened men proverbially live long, and vested interests may succeed in postponing the change till our industries are all but ruined, but sooner or later it must be made.

The records of the North East Coast electric power companies show that the coal expenditure per horse hour in factories with independent power plants averaged 7 lbs. The corresponding equivalent coal consumption per horse-power hour for current from the power companies' mains, as delivered by them at the consumer's terminals, is 1.54 lb. The consequent saving in coal used for power purposes in the district is 1,365,000 tons per annum. The coal conservation committee estimate that at the present time 80,000,000 tons of coal are annually expended on power production within the United Kingdom, having a pit-head value of at least 40,0000,00*l.* sterling. By organising on proper lines the power supply of the country a saving of at least 55,000,000 tons would be effected, or alternatively if the same quantity of fuel were consumed as before, some 15,000,000 additional horse-power would be available, and the establishment of electro-chemical and electro-metallurgical industries, hitherto almost confined to countries with cheap water power, would be perfectly practicable. At present there are 600 authorities distributing electricity in as many separate districts. For many reasons salvation can not be found in the linking up of these, a procedure which would be analogous to our railways being divided up amongst the municipalities, and long distance working being effected by running agreements. Actually this comparison is too favourable. Small stations can neither engage the skilled scientific staff necessary to secure the highest fuel economy, nor can they profitably extract by-products from their coal before using it for fuel. Also the plant costs more per kilowatt installed. It is essential, therefore, that the stations shall be very large, that they shall be situated where fuel is cheap and condensing water is plentiful. Moreover, it will be practicable to utilise at such stations, if suitably situated, much good coal, too friable to stand transport, and much poor coal, which is of too low a quality to carry heavy freight charges and is accordingly now left below bank.

The committee recommend that the whole country shall accordingly be divided up into 16 areas of supply, each under one authority, dealing with generation and main distribution. The sites should be chosen forthwith, and should be as large as possible, partly to permit of a proper subdivision of the station, but also to provide room for subsidiary processes such as the extraction of by-products from the coal and for electro-chemical or electro-metallurgical factories which are most conveniently located as close as possible to the power plant. The electrical authority for the area should, it is advised, be the authority not only for generation but for distribution, as where bulk supplies are taken the distributor retains an inordinate proportion of the profits and thus raises the price of power.

The committee discuss, but dismiss as certain to be inefficient, the direction and control of the undertakings by the community, a view which experience during the past three years has done much to popularise. The matter should either be left in private hands, with provisions, as with gas undertakings, to ensure a distribution of profits from future economies fairly between the producer and the consumer, or the undertakings might be joint enterprises, public authorities entering into partnership with a company. Sveral precedents for this are in existence. The Persian oilfields are being developed by a corporation of this kind, and the treasury has invested largely in British Dyes. The advantages claimed for such a union of interests is that on the one hand capital can be raised more cheaply, and on the other, more efficient management is secured. It might possibly also facilitate the task of dealing with a not improbable attempt on the part of the labour employed in such giant stations to exploit in its own interests all the rest of the community. Experience has shown that State and municipal undertakings are as subject to strikes of labour as are those privately owned and directed, but where the demands made are obviously unfair, the public in general is more tolerant of drastic action should this become necessary when it is itself owner, or part owner, of the enterprise attacked.

The large undertakings recommended in the report would be able to utilise much heat now wasted at collieries and steel works. Their "diversity factor" would also be large, and hence it would be possible to instal a much smaller aggregate plant capacity than would be necessary were the same area served by numerous isolated stations. To some extent the same end might be secured by linking up these latter stations, but whilst useful as an emergency measure this linking up will, as already pointed out, tend rather to perpetuate an inherently uneconomical system of electric power generation and distribution.

A difficulty to be overcome in connection with the plan recommended lies in the large variety of the frequencies now in use. Here again, however, the committee consider that the difficulties will be more political than technical, and they recommend that for the area lying south of a line drawn from Carlisle to the Humber the standard shall be 50 cycles per second, though possibly another standard might be desirable in the Black Country. For the rest of England a frequency of 40 is suggested, and for Scotland one of 25.

THE WAR AND THE RUSSIAN INDUSTRY AND LABOUR.

APPARENTLY Russian labour is doing its best to destroy Russian industry. When the men claim rises in wages from 200 per cent. to 500 per cent., and at the same time want the hours reduced from the former 10 to 12 hours to 8, 6 and even 4½ hours, it goes without saying that industry and capital are being taxed out of existence. A few examples will show how impossible are the demands made upon capitalists. From the coal industry of the Donetz district there were despatched during the first seven months of last year (1917) 980,000 railway truck loads of coal less than during the corresponding period of the previous year. In July the production receded to 1,900,000 tons against 2,250,000 tons for the same month of the preceding year, and the number of hands had risen from 238,000 in June, 1916, to 274,000 in July, 1917. That is 15 per cent. more hands and 16 per cent. less output. This, with other causes, has raised the former price, that is, the peace price, of coal of from 7 kopeks to 10 kopeks per pood (36 lbs) to 25 kopeks per pood at the mine, which price more recent claims for higher wages have further swelled to 60 kopeks per pood, which would come out at about 4*l.* per ton, assuming the paper rouble to be at par value of 2*s.* 1½*d.* What is the exact value of a rouble now it is impossible to say. Since it really constitutes a promise to pay on the part of the Russian Government, the rouble remains a subject of speculation until the Government attains to a condition of stability. It is now quoted in London at rather less than sevenpence. Of course it is worth more in Russia, but it is impossible to say how much. Even in this country the value of the sovereign is a very indeterminate sum, in terms of subsistance. Turning from coal to other industries, we find the iron production of the Ural has receded 15 per cent. to 40 per cent. In Petrograd 43 concerns in the iron and electric industry were standing idle in the beginning of August. On September 1 the Petrograd Lescher factory threatened to close up, having obviously lost 400,000 roubles through inflated wages. Compared with same period of the previous year, the men's output had been reduced to one-half, whilst their pay had been quadrupled. A Russian expert estimates the reduction in the entire industrial output of Russia at 30 per cent. to 40 per cent., and for the Petrograd works alone at 60 per cent. to 70 per cent.

In the Moscow metal works between 1915 and 1917 the production per hand fell over 62 per cent., whilst the wages for the same unit rose 950 per cent. Coupled with the decrease in output there was a deterioration in the quality. This tremendous rise in wages was not caused by a rise in prices; the reverse is the case, it was the high wages which tended to raise prices. The fact that a railway labourer, already in August, received 9 roubles per day against a previous monthly wage of 70 roubles to 90 roubles, or that similarly situated hands at the military and naval establishments, by constant threats of striking, managed to screw up their monthly wage to from 1,000 to 1,500 roubles, could not be justified by the general level of prices. It is not necseary to point out that these movements in wages have nothing to do with industrial conditions or contingencies, but simply are the upshot of utter political disorganisation and confusion.

Two agencies can be discovered behind this labour movement, if one may so call it. The one is that class of Russian known as the Intellectuals, many of whom use the working man as a stepping stone for their own often confused and muddled ambitions. They aim at a "socialising" of industry and a national expropriation of capital. The State, the new State, is to take over the despoiled works, and carry them on for the benefit of the men—the real earners of profits. How the State is to manage this financially does not seem to concern them. As an instance of what this would cost, we refer to the Putiloff works, which employ some 30,000 hands. In the beginning of August the management stated that they could not carry on unless they received a State subsidy, of 90,000,000 roubles. The rate of production had fallen 35 per cent. to 40 per cent., whilst the wages had risen 270 per cent, the result being a loss of 4,000,000 roubles per month. And yet these works are under military protection and State control. A congress of workmen recently decided that if an employer, in case of a strike, refused to grant the men's demands for higher wages, then the State was to take over the works, and they were to be carried on under some local management.

The Russian workman is not able to grasp the real nature of the matter or to form a sound opinion about the actual state of affairs. He works well enough under strict, perhaps even rigorous control and supervision, but the smallest relaxation of the accustomed rigid conditions leads to dilatoriness and worse. He will not, or cannot, realise that wages, which in themselves may be somewhat inadequate, are the necessary outcome of the prevailing industrial and commercial conditions. When all the old restrictions give way, when he all at once feels himself free and more like master than servant, then he becomes uncontrollable and utterly unreasonable. He falls the easiest possible prey to any self-appointed "leader," who understands how to flatter him and appeal to his often undesirable instincts. The word "strike" with the Russian workman has a very comprehensive meaning, often including the murder of engineers and foremen, the driving away or locking up of unpopular managers, sabotage, arson, &c. If this leads to stoppage of the works, the foremen and managers are arrested and compelled to carry on the concern, or the men choose their own managers, or consider the old engineers *their* servants, and treat them accordingly.

The utterly unreasonable and impossible demands of Russian labour appear from a statement in the *Novoie Wremia* of June 27, 1917 (and matters, of course, have grown much worse since then) that in order to satisfy the demands of labour for the entire industry, the Russian State would have to find 9,500,000,000 roubles out of an estimated

aggregate revenue of 15,000,000,000 roubles, or about two-thirds, and yet the hands in question only number about 5 per cent. of the entire population. In the town of Zaritzyn, on the Volga, 3,500 harbour and railway hands for loading and discharging, which number includes women and lads, have enforced a daily wage of 13 roubles, for an eight hours' attendance, which includes three hours for dinner and 15 minutes of each remaining hour "for an airing." This, nominally, comes out at about 7*s.* per working hour of 60 minutes against a previous daily wage of 2*s.* to 4*s.*

As a result of this state of labour the cost price for pig-iron rose from the old figure of 40 kopek to 1 rouble 60 kopek in May, 1917, and was almost bound to rise to double that price or more, if the men had it their own way. Iron ore which in times of peace was produced at 9,75 kopeks cost in March, 1917, the beginning of the revolution, 15,5 kopeks, but in July the figure rose to 25,5 kopeks, or really according to the wages demanded to 42 kopeks. In 1914 the weavers earned an average of 91 kopeks per day, during the summer and autumn of 1917 the manufacturers conceded a daily wage of 3.25 roubles, but the weavers insisted upon 5 roubles. The employers in Iwanowo-Wosnessensk offered, in May of last year, in vain four times the old wage. What this state of affairs means for Russian industry need hardly be pointed out or can, rather, not be duly conceived. About July 18, works within the South Russian iron industry, with an aggregate capital of 195,000,000 roubles, had already granted increase in wages amounting to an aggregate of 64,000,000 roubles against aggregate profits amounting to 75,000,000 roubles, when the men raised further demands amounting in the aggregate to 240,000,000 roubles for the year.

The above particulars will suffice to show the hopeless muddle of Russian labour at present, and the disastrous position of the industry of the country.

THE LATE SIR WILLIAM HEERLEIN LINDLEY.

THE death of Sir William Heerlein Lindley last Sunday, the 30th ult., at his residence, 74, Hazlewell-road, Putney, calls to mind the period when Britain was the sole centre of municipal engineering. By slow stages Continental cities followed our lead in water works, gas works and sewerage systems, but in very many cases they were obliged to call in British engineers to advise them. Indeed, in some instances plumbers from this country were sent abroad to execute the details of the schemes and to erect house fittings, there being no available source of such skilled labour on the spot. Prominent among the British engineers who introduced higher sanitary conditions abroad was Mr. Walter Lindley, the father of Sir William, and at his death the subject of this memoir worthily filled his place. Successively, father and son for some seventy years represented to Continental nations all that was best and most efficient in sanitary science from the engineering point of view.

Sir William Lindley was born on January 30, 1853, at Hamburg, and received his classical and scientific education at Blackheath, London. He was, as stated, the son of the late Mr. W. Lindley, who exercised the profession of civil engineer at Hamburg and other Continental towns. Mr. W. Lindley was an English railway engineer who had worked on the Newcastle-Carlisle and on the London-Southampton railways, and who, in the late 'thirties of last century was called over to Germany to design and carry out one of the first railways on the Continent, the line from Hamburg to Bergedorf, the first step towards Berlin. Sir William commenced his professional career as early as 1869 in the office and in the works of his father, and he acted as his father's representative on the works for the supply of the city of Budapest with water from 1870 to 1873. In this responsible position, he worked out the designs for and directed the execution of the work, having, moreover, to advise the city authorities in regard to them. He left Budapest in 1873 to report on the water supply of Braïla, Galatz and Jassy, in Roumania, and to prepare designs for the work in these three cities. He commenced in October, 1873, to be more especially engaged, as his father's assistant, in the construction of the sewerage works for the city of Frankfort-on-Main, in which position he had not only to act as resident engineer, working out designs and superintending execution, but also to direct the whole of the house drainage which formed an integral part of the sewerage system.

On the retirement of his father, in 1878, he became the chief engineer to the city of Frankfort. In 1879 he was made responsible also for the water supply, and in 1882 was appointed municipal engineer, which position he held until the year 1896, when he resigned at his own request.

The work which Sir William carried out in Frankfort comprised the extension of the sewerage, sewerage purification works, harbour accommodation, embankments, wharfage, extension of water supply, electric central station and many other municipal undertakings. He took an active part, as President of the Commission for Electric Investigation, in the

Elliott and Fry, Photographers.

SIR WILLIAM HEERLEIN LINDLEY.

Frankfort Electric Exhibition of 1891. In the year 1880, he took over his father's practice outside Frankfort, and in the course of his activity in this direction he planned and carried out important works in Austria, Germany, Poland, Roumania, Russia and Serbia, in sewerage, water supply and electric power distribution. The most important are the sewerage works at Prague, Mannheim, Warsaw and Elberfeld; the water supply of Warsaw, and the electric stations at Elberfeld and Mannheim. Sir William introduced the Parsons steam turbine at Elberfeld in 1898, when he erected the two pioneer turbines in Germany. These were each 1,000 kilowatt machines, and marked a large step forward in the use of steam turbine units. The importance of Sir William's courageous decision in this case cannot be exaggerated, since the steam turbine is essentially a large unit machine, being heavily handicapped when required to compete as a small unit with reciprocating engines.

During the cholera epidemic at Hamburg, in 1892, he secured special service as member of the Commission for River Water Filtration, appointed by the German Government Board of Health. He received various medals and distinctions in recognition of his works—at Turin, in 1890; Chicago, in 1893; Lemberg, in 1894; &c. He was also delegated to report officially at various continental congresses, notably in 1888, at the Congress on Inland Navigation, held at Frankfort; in 1889, on Water Supply in Paris; in 1894, on hygiene and demography at Budapest. He was also at one time President of the Commission for the Standardisation of Water Meters and of the Commission on the Electrolysis of Gas and Water Mains, appointed by the Institution of German Gas and Water Engines. Sir William was also a member of various Commissions of other German and Russian scientific bodies.

Sir William was a member of the Institution of Civil Engineers since 1878. He received a Knighthood in 1911 in recognition of his services to the British Royal Commission on Canals and Waterways He was President of the Junior Institute of Engineers in the year 1904–1905, and on his appointment he delivered a presidential address on "Municipal Engineering on the Continent." This address covered waterworks, sewerage, electricity and river regulation; it dealt extensively with the work carried out in these four fields of activity on the Continent by Mr. Walter Lindley, his son, Sir William, and other British engineers, over a period of sixty years.

Last April, Sir William had the satisfaction of learning that one of his great undertakings, the supply of water to Baku, was an accomplished fact, after twenty-one years of preliminary operations and developments, and despite war difficulties. It was announced last July that by an unanimous decision of the Duma of the City of Baku, he was to be presented with the freedom of the city, in recognition of his great and successful work in carrying out its water supply. The work involved the supply being brought over a distance of 112 miles from the mountains in Caucasus.

Other extensive schemes of his, among which we may mention one for the water supply and the drainage of Petrograd, are still pending.

GERMANY'S DESIGNS ON FRENCH IRON ORE.

THE iron and steel manufacturers in Germany form a compact and very powerful body. They act in concert with manufacturers, such as toolmakers, engine-builders, shipbuilders and the like, and their combined influence is keenly felt by the Government, which is always alert to further their interests. It will be remembered that the despatch of the "Panther" to Agadir, which sent a shiver through Europe, was prompted by the interest felt by German ironmasters in regard to the iron ore deposits in North Africa, and the desire to secure a share of them. The potent position held by the so-called heavy industries in Germany is also demonstrated by the enormous profits they have been permitted to make during the war, in spite of repeated protests from less-favoured manufacturers. So strong are they that they are now repudiating all suggestions of conciliating their foes, and are insisting that the terms of peace shall be drawn so as to increase very materially the existing supplies of ore within the German Empire. This point was brought forward at a recent meeting of the Union of German Iron and Steel Industries, which comprises blast-furnaces, steel works and rolling mills, bridge and wagon-building concerns, shipyards, many manufacturing engineers, iron and steel foundries, finishing works, &c., when a resolution was passed to the effect that it was necessary for Germany to retain the possession of the Briey and Longwy iron ore deposits and to ensure an efficient supply of Russian iron and manganese ores.

In the report of the Union for the third year of the war reference was made to the working of the Act relating to the Civil Patriotic Auxiliary Service. It was pointed out, that owing to this measure being carried out through the medium of the trade unions, it had had the opposite effect to that which was intended. The plan of the obligation to work being made compulsory had in reality been frustrated, and the banner of freedom of labour had been hoisted in the midst of the war. Many clauses of the Patriotic Service Bill really favoured migration of labour, thereby helping to force up wages to a level that must cause grave apprehensions as to Germany's ability in the future to compete in the world's market.

It was further stated that the endeavours of the Union to increase productive capacity had been aided by the Social Democratic Under-Secretary of State, Dr. August Müller. The attainment of

the ends in view would not only require peaceful conditions for labour, improved means of communication, the guarding of the home market against foreign competition, but also an extension of the borders of Germany to make sure of the supply of raw materials for industry. In these respects, continued the report, all other great Powers are better situated than Germany; they have plenty of bread and plenty of raw materials. The retention of the French iron ore deposits, on which the German iron industry insisted, was necessary, for the home deposits would only hold out for four or five decades. It was also important to secure a supply of phosphorus to increase the yield of the German soil. The enemies of Germany knew that without an extension of her iron ore resources she would, in another fifty years, be unable to carry on a war with her own iron.

Of no less importance was the protection through an adequate tariff of the home market against foreign competition. As regards State working or private working of industries, it was certain that the latter yielded better results, and consequently it would also, in the long run, have the greater capacity. This would, on principle, lead to the rejection of the so-called coercive syndicatising. Reference having been made to the coal tax, the increase of the war-profit tax, the rise of the railway rates and the impending further increase of 15 per cent. on goods rates, the necessity was emphasised of these increased rates being abolished as early as possible after the conclusion of peace.

A speaker at the meeting touched upon the iron ore problem. Before the war, he said, 50 per cent. of the ore necessary for Germany's production of 16,800,000 tons of pig-iron, had to be imported. In the course of forty or fifty years Germany's iron ore deposits would be about exhausted. France could perfectly well give up to Germany the necessary quantities of iron ore, without doing her own industry any harm. Russia was in a similar position. In the Krivoi-Rog basin in the Ukraine, there were enormous deposits of the most ideal ore for Bessemer pig-iron, which were of the greatest importance both for the Upper Silesian and the West German iron industry. The Polish deposits could supply some 100,000 tons of iron ore annually to the Upper Silesian iron works, and the Swedish iron ore from the vast deposits in Lapland would also be of importance in the future. In addition it would be necessary for German iron works to secure their share of the extensive and valuable ore deposits in Brazil. As regards manganese ore the immense deposits in the Caucasus and other parts of Russia stood at the head of the list, and it must be remembered that for this essential commodity Germany was entirely dependent upon imports from abroad. The safe supply of iron and manganese ore must be kept in the foreground at the peace negotiations, for on this hung the continued existence of German industry, the German State and the German people.

Some time ago the original growth of this union of German Iron and Steel Industries was traced by Professor Sir W. J. Ashley before a meeting of the Staffordshire Iron and Steel Institute,* and incidentally the resources of the Briey and Longwy basins were described. The Professor said that in 1879 the German iron manufacture had been undefended by customs duties for two years. The output of pig iron was then 2.2 million tons, or rather less than in 1873. But from 1879, after the imposition of a substantial tariff, the output increased every single year down to 1890, when it reached more than 4.6 million tons. In 1893, Germany surpassed this country in the production of crude steel, turning out 3.1 million tons against Britain's 2.9. It was still behind in pig-iron production, but only 10 years were needed before, in 1903, Germany outstepped this country in iron also. In 1892–3, the syndication movement in the iron and steel industry began to achieve substantial success. In 1892, the German pig-iron producers came together, and in 1893 the Westphalian Coal Syndicate was formed. In the following years the example was followed in the various branches of the steel trade. These sectional combinations usually began with a mere price agreement; next they had to apportion the sale; and then they found it necessary to concentrate all the marketing of their commodity in a common selling organisation. The most important was the syndicate of makers of ingots and billets, called the *Halbzeugverband*, or Semi-Finished Steel Syndicate. In 1904, the three syndicates just mentioned united in the Stahlwerksverband, which has commanded the position ever since. Towards the close of last year the entire output of iron and steel and products of every kind had been brought together under four Central Iron Offices for war purposes.

An important part of the business of the syndicate consisted in dumping surplus stocks in foreign markets. This led to complaints that the stocks were worked up into finished products in foreign countries, and sold in neutral markets at lower prices than German manufacturers, using full-priced steel, could compete with. Then the system of bounties was inaugurated. In 1913, the bounty on exported coal and coke was raised from 1*s.* 6*d.* to 2*s.* 6*d.* per ton; that on pig iron from 4*s.* 6*d.* to 6*s.* 3*d.* per ton; that on semi-finished steel used in manufactures from 10*s.* to 15*s.* per ton, and so on. Since 1902, German exports of iron and steel have advanced, at first hesitatingly, and then by leaps and bounds. In 1910, they went ahead of those of Great Britain. The whole story, says Professor Ashley, from 1902 onward, not only indicates that the bounty system no longer puts the German user of steel material at a disadvantage in foreign markets, but also that the dumping policy, originally adopted to relieve the pressure on the home market and carry off a temporary surplus, has become the permanent policy of the German steel-producers.

The fact that Germany has definitely adopted the policy of keeping her works in full operation whether the home demand be brisk or dull explains her anxiety to include within the Empire some of the ore deposits of France. To what extent she already draws on these sources is shown by an article on French Lorraine written by Dr. Schlenker, Syndic of the Chamber of Commerce, Saarbrucken, in which he stated that the annual extraction in the Briey Basin of ore containing 5 million tons of iron equalled about 67 per cent. of Germany's imports of metal, and 28 per cent. of her supply of metallic iron. The German imports of iron ore from France rose from 45,600 tons in 1901 to 2,122,900 tons in 1911 and to 3,810,000 tons in 1913. In the latter year the imports from Spain were 3,632,100 tons and from Sweden 4,558,400 tons, but both the Spanish and the Swedish ores were richer in iron than the French ores. The ore supply of Germany for 1913 was as follows:—

	Ore. Tons.	Iron in Ore. Tons.
Extracted... ...	35,941,000	10,541,500
Imported... ...	14,019,000	7,710,400
	49,960,000	18,251,900
Exported... ...	2,613,000	783,900
Home consumption	47,347,000	17,468,000

Hence, 44 per cent. of the contents of iron in the ore came from abroad. From France, there came, as stated, 1,410,000 tons of iron, equal to 18.29 per cent. of the imports.

In view of the German designs on her ore it is no wonder that France fought so splendidly at Verdun which is close to the coveted area. On the principle of *beati possidentes* it was worth while to make the enormous sacrifices for, as stated, by Senator Berenger, the Secretary of the National Defence Committee, "The ore basin of Briey is the battlefield on which France and Germany are fighting for the dominion of iron."

THE CENTENARY OF THE INSTITUTION OF CIVIL ENGINEERS.

LAST Wednesday, the 2nd inst., was the hundredth anniversary of the first meeting of the Institution of Civil Engineers. That meeting took place at the Kendal Coffee House, Fleet-street, and only comprised eight members, none of whom, it is fair to suppose, realised how great and important would be the growth of the small society that was then inaugurated. In the Minutes of Proceedings of the institution, the first volume of which appeared in 1837, are to be found descriptions of practically all the great engineering works of the past hundred years for which British engineers have been responsible, in addition to those of many undertakings carried out by foreign members. These volumes are a storehouse of engineering science and practice of the greatest value, and provide irrefragable evidence of the immense benefits which our profession has conferred upon humanity not only at home, but in all parts of the world.

More patent testimony to the success of the institution, and to that of the profession, is afforded by the splendid house in Great George-street, Westminster, which was recently erected at great cost, after the society had sought again and again enlarged premises to accommodate its constantly increasing numbers. The first meetings were held in the Kendal Coffee House, or Gilham's Coffee House, and at the King's Head Tavern, Cheapside. After a year or two rooms were taken at 15, Buckingham-street, Adelphi, and in 1834 a small house was taken at No. 1, Cannon-row, Westminster. When this was outgrown a move was made to Great George-street, but those premises had to be rebuilt in 1846, while further reconstruction was needed in 1865. In 1894 a very fine building was put up likely to serve for a long period, but this was acquired after some years by the Government, and in 1913 the present building, on the opposite side of the street, was completed.

Next Tuesday, in this house, official notice will be taken of the fact that the second century of this history of the institution has commenced, and in reporting the proceedings we shall be able to go more completely into its growth and progress. Had it not been for the war the completion of the first century of its existence would certainly have been celebrated by the Institution on a much more imposing scale, and it is to be hoped that such a celebration will only be deferred and not abandoned. After peace has been declared the opportunity should be taken to call the fullest attention to the great share the civil engineer has borne in securing it. The importance of that share has certainly not yet been adequately recognised by the Government nor by the nation generally, and it is the duty of the Institution and kindred bodies to take such steps as are necessary to secure a better appreciation of the claims of the engineering profession.

NOTES.

ELECTRIC JAPANNING.

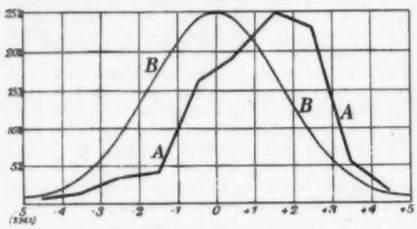
TRUE japanning is effected with the juice of the *Rhus-vernicefera*, and is a lengthy process, though true japan shows great resistance to attack by atmospheric or other corroding agencies. In ordinary japanning as carried out in Western countries, use is made of an asphaltum base combined with oils, driers and various oxides. According to Mr. C. D. Carlson, in a paper read before the Cleveland Engineering Society, the operation may be divided into two stages. During the first stage the solvents used keep the material liquid until it flows evenly over the surface to be coated, and then evaporate, leaving a smooth viscous covering. In the second stage this viscous covering is converted by oxidation at a high temperature into an elastic solid. The time required for the process has, he states, been greatly reduced during the past few years. Most manufacturers who formerly allowed 5 hours to 9 hours for their baking operations, now do the same work in 30 minutes to 1 hour, and in the laboratory satisfactory results have actually been secured in 10 minutes by electrically generating heat within the part to be japanned. In commercial work another electrical process is, Mr. Carlson says, being used. In this, the japanning oven is heated by electric radiators. These are formed of nickel-chrome resistances in the shape of flat ribbons. These are non-corrodible even at temperatures of 800 deg. C., which is a higher figure than is required in japanning, where 600 deg. C. is seldom attained. These heating units are made in different sizes, being rated at 2½ kw. to 10 kw. each. They are small, and can be distributed over the japanning oven so as to ensure a practically even temperature throughout.

* "The German Steel Syndicate and the British Steel Industry," by Professor Sir W. J. Ashley. Stourbridge: Mark and Moody, *County Express* Offices, High-street. See also the *Quarterly Review* for April, 1917.

Mr. Carlson states that with this system of heating a higher gloss and finish are obtainable than can be arrived at in other ways. The electric method of heating, moreover, makes it easy to control the furnace temperature with great accuracy.

THE ERRORS IN INTERCHANGEABLE PARTS.

Interchangeability of manufactured articles is secured by making all details to within known limits of size, and these limits are set with sufficient closeness to ensure a satisfactory fit even should the largest permissible size of one part coincide with the smallest permissible size of the part to which it fits. In considering the results obtained by working to limits in the machine-shop, one is apt to assume that the average size of accepted work will be half-way between the allowable limits, and further, that the distribution, between those limits, of the errors in the dimensions will be in accordance with the "law of normal error." These assumptions are natural, and it is usual, therefore, to set the permissible limits of size equally above and below the nominal size of the article. Since, however, all machining operations are effected by the removal of metal which there is no means of replacing, it appeared likely that the natural caution of the operator might have a tendency to cause the work to be generally finished a little on the "high side" so as to be further from the danger of being under size. The point is interesting, because if such a tendency existed, the limits might be set so as to cause the bulk of the work to conform as nearly as possible with the nominal size, and thus to ensure a better general average of fit with the same overall limits of machining. To determine this point some measurements have been made at the works of Messrs. John A. Prestwich and Co., of Tottenham. A stock of 74 finished crank-pins were taken from the stores, and their diameters were measured by means of the Prestwich



fluid gauge. The instrument was set so that the first pin tested caused the gauge to read zero on the scale, and check measurements were taken several times with the same pin, in order to see that no error due to temperature or other cause was affecting the readings during the course of the experiment. The gauge was graduated in ten-thousandths of an inch, but it could be read by eye to the nearest forty-thousandth of an inch, and the readings were actually recorded to this accuracy. Possible slight errors of parallax, and in estimating the quarters of a division, of course render these readings doubtful, so far as the final figure is concerned, and in collating the data, the readings were grouped into batches, each with a range of one ten-thousandth of an inch. After all the pins had been measured, they were shuffled and a second set of measurements taken. These were found to agree remarkably well with the first set, especially considering the extreme fineness of the readings. The curve A in the accompanying diagram shows the mean of the two sets of readings, the ordinates representing the percentage of the pins whose dimensions fell within the limits shown on the base of the diagram. Curve B is the curve corresponding to the "law of normal error" and is given for comparison. It will be seen that all the pins came within a range of ± 0.0005 in., of the nominal size, which is represented by zero on the diagram. The "mode" or most fashionable size was from one to two ten-thousandths of an inch above the nominal size, and 25 per cent. of the pins fell within this range. The "median" or the size above and below which an equal number of pins were found is about one ten-thousandth of an inch above the nominal size. The experiment appears to show that in order to obtain the greatest number of pins of the nominal size, with the same accuracy of workmanship and the same range of limits, it would be better to fix the latter at + 0.00035 in. and − 0.00065 in. instead of setting them ± 0.005 in. above and below the nominal size.

NEW YEAR HONOURS.

THE usual list of honours conferred by the King was issued on New Year's Day. It is a particularly long one, and is notable for the distinctions conferred on the officers of the Army and Navy. There are, however, relatively few leaders of industry included, but these no doubt will come more appropriately in the list of appointments and promotions to the Order of the British Empire, which is to be issued on Monday. We give first place to the Navy list, and record with satisfaction the Knight Commandership of the Bath conferred upon Engineer Vice-Admiral George Goodwin Goodwin, C.B. Admiral Goodwin has long been identified with the design and construction of naval machinery, first in association with the Director of Dockyards, next as assistant to Sir Henry Oram, and finally as the latter's successor as Engineer-in-Chief. The Deputy Engineer-in-Chief, Engineer Rear Admiral Edouard Gaudin, becomes a C.B., as also does Engineer Rear Admiral William Frederick Pamphlett and Engineer Captain Robert Bland Dixon, R.N. Mr. Frederick William Kite, M.I.C.E., who has done such splendid work in the Director of Works Department of the Admiralty for so many years, also becomes a C.B. The distinction of C.M.G. has been given to Captain A. R. Emdin, R.N., while a D.S.O. has been conferred upon Engineer Commander Mark Rundle, R.N.

The ordinary, or what is termed the Prime Minister's, list, states that His Majesty has conferred the dignity of a Viscount of the United Kingdom upon Baron Furness, so closely identified with shipping and shipbuilding, steel, iron and colliery undertakings, as was his father. One of the new peers is Sir James Woodhouse, who, as one of H.M. Railway Commissioners since 1906, has been working in connection with railway transport.

We are glad to note the inclusion amongst the new Privy Councillors of Mr. Tom Richards, general secretary of the South Wales Miners' Federation since 1887, and Labour M.P. for West Monmouthshire.

Amongst the twenty new baronets is Mr. Frederick William Lewis, deputy chairman of Messrs. Furness, Withy and Co., and chairman of many other shipbuilding, &c., companies, and director of twenty shipping and shipbuilding and other industrial companies.

Amongst the new knights are Mr. William Nicholas Atkinson, a leading mining engineer, who has contributed largely to the investigation of the effects of coal dust in mines, has written many books on explosions in mines, and served for many years as inspector of coal mines. Many engineers, too, will be glad to note the inclusion of Mr. Thomas Putnam, managing director of the Darlington Forge Company, where so many of the finest forgings for naval and mercantile machinery have been produced under his direction.

The Indian list includes a knighthood to Mr. Arthur Robert Anderson, a member of the Indian Munitions Board, and to Colonel H. A. L. Hepper, agent of the Great Indian Peninsula Railway Company.

The Colonial list includes a C.M.G. to Mr. P. A. Anthony, general manager of the Federated Malay States Railway.

DUST COLLECTOR.—In order to collect the dust raised during sand-blasting and other processes, Alfred Guttmann, of Altona-Ottensen (*Stahl und Eisen*, October 11, 1917, pages 927 and 928), discharges the dust through an elbow ending over a water bank. The mouth of the duct is partly closed by a cone, and from a perforated tube inserted in the lower part of the duct, a spray of water is injected and strikes the cones. The dust and the rebounding water globules mix and fall into the tank below. The rising air has to pass through a coke filter, which retains the fine dust particles.

NATURAL GAS AT NEUENGAMME.—We have several times referred to the outburst of natural gas, which occurred at Neuengamme, near Hamburg, several years before the war and which is still maintained. According to Schröter the composition of the gas did not much change in the three years 1913 to 1916, as the following percentages will show (those in brackets refer to 1916): Methane, 95.5 (97): ethane, 1.5 (0.6): nitrogen, 3.2 (2.4): density, 0.574 (0.604). The source belongs to the State of Hamburg. A pipe line of 210 mm. diameter conveys the gas to the gasworks at Tiefstack, 15.4 km. distant, where the gas is added to the coal gas for illuminating Hamburg: a further line, 1.8 km. in length, 150 mm. and 100 mm. in diameter, leads the gas to Rothenburgort, where the gas is burnt under steam boilers. The gas enters the burners under the boiler at a pressure of 400 mm. of water: the pressure in the first main is 3.4 atmospheres. The ratio of the calorific value of gas to coal has turned out to be 1 : 1.14.

YEAR-BOOKS AND ANNUALS.

Almanacks and Calendars.—We have received from Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, Openshaw, Manchester, a very effective monthly tear-off calendar, depicting the sinking of the *Blucher*. Messrs. Cammel Laird and Co., Limited, have sent us an almanack illustrating, for the first six months of the year, women's work in a shell factory and for the second half year, H.M. frigate *Birkenhead*. A nicely got up monthly tear-off almanack for 1918 and 1919, showing Spithead in 1914, has been issued by Messrs. Arthur Balfour and Co., Limited, Sheffield. Daily tear-off almanacks have been sent us by Messrs. Ashwell and Nesbit, engineers, Leicester; Messrs. Hopkinson, Huddersfield; the Davenport Engineering Company, Limited, Bradford; the Perfecta Boiler Circulator Limited, 39, Victoria Street, S.W.; Henry Simons, Limited, Manchester, the leaf for each day giving a motto. A set of refill cards has been also sent us by the Welin Davit and Engineering Company, Limited, London. Other monthly tear-off calendars have been received from Messrs. Geo. Cradock and Co., Limited, wire rope works, Wakefield; Messrs. Charles Churchill and Co., Limited, Pendleton, Manchester; Messrs. Peckett and Sons, Bristol; the Westminster Tool and Electric Company, Suffolk House, Laurence Pountney Hill, London, E.C.; the Kennicott Water Softener Company, Wolverhampton; Messrs. George Fletcher and Co., Limited, Derby. We have also received a universal calendar from Messrs. Brown Brothers, Limited, 22-34, Great Eastern Street, London, E.C., and from Messrs. Wm. Asquith, Limited, Halifax.

Diaries.—Messrs. Cammell Laird and Co., Limited, have sent us a pocket diary for 1918, which gives metrical and other units, Brinell hardness numbers, &c., and contains several leaves of squared paper for diagrams. We have received from *The Ironmonger* a copy of their diary, the fiftieth edition, which contains also a large amount of useful information. The International Mercantile Diary and Year Book issued by Syren and Shipping, Limited, gives an extensive series of conversion and other tables, together with other useful information for reference purposes. We have, further, received from Messrs. Hayward, Tyler and Co., Limited, 99, Queen Victoria Street, E.C., a copy of their handy pocket diary, containing data on pumps, pipes, &c.

THE NEW ISSUE OF "THE BOARD OF TRADE JOURNAL."—*The Board of Trade Journal* is published in a new form and with a greatly extended scope, commencing with the issue for the 3rd inst. The aim is to give authoritative information upon all the activities of the Board of Trade and of the new department formed jointly with the Foreign Office. Special attention will be paid to plans for assisting trade restoration after the war. Official information concerning Government Orders affecting trade, Customs regulations and tariffs, openings for trade, &c., will continue to be given, and advantage will be taken of the improved and developed service of Trade Commissioners within the Empire and of Commercial Attachés and Consuls' services in foreign countries, to secure for publication in the Journal fuller reports on oversea markets. The President has appointed Mr. Harcourt Kitchin, late editor of *The Glasgow Herald*, as editor of the new issue of *The Board of Trade Journal*. The price of the new series will be 6*d.* (post free 6½*d.*), the annual subscription including postage in the United Kingdom being 27*s.* 6*d.* Existing subscribers will receive their copies without additional charge until their current subscriptions have run out. All communications should be addressed to the Editor, *Board of Trade Journal*, Whitehall Gardens, London, S.W. 1, or 73, Basinghall-street, London, E.C. 2. The publishers are H.M. Stationery Office.

CHROMIUM-STEEL FOR MAGNETS.—Owing to the commandeering of tungsten for military purposes, German electricians found themselves without tungsten for their magnet steels early in the war, and experiments on the use of chromium in the place of tungsten, which had already been projected before the war, were accelerated. The research has been conducted in the Reichsanstalt on behalf of the Verband Deutscher Elektrotechniker. The preliminary report, published by the Reichsanstalt in 1917, did not give particulars, which were, however, to be communicated to members of the Verband on inquiry. Krupp's works supplied 37 specimens of steel containing varying percentages of chromium and of carbon: they had been turned into rods and hardened in various ways in the works, and were then aged, after the method of Strouhal and Barus, by repeated heating, cooling and mechanical stress, while being tested at intervals in the Reichsanstalt. The unfinished investigation concerns also the temperature coefficient of magnetisation and the durability of the steels. It results that on an average chromium steels, which have undergone suitable heat treatment, do not rank below tungsten steels: the very best magnetic chromium steels, however, are not equal to tungsten steels. Technically, chromium steels would thus appear to be quite satisfactory, while for special researches their further improvement is desirable.

LOSS OF TIME IN SHIPYARDS AND IN MUNITION FACTORIES.

TO THE EDITOR OF ENGINEERING.

SIR,—Many of your readers must have been interested in the article which appeared in your issue of September 14 last upon this important subject. May I be allowed to make a practical suggestion, which is intended to meet the present difficulty, in providing buildings which are necessary for feeding the operatives at a dining hall within the works: and for sleeping those who are the most essential to be prompt in commencing at the hour, instead of being, often unavoidably, late. It has been recognised by the authorities that wood for building is not only expensive, inflammable and difficult to obtain, but that hutments are devoid of comfort, badly insulated, tedious in erection and involve a maximum of labour and a minimum of durability. Concrete has been tried, and has proved a failure, in several important particulars. Concrete houses are very cold, and condensation inside, of moisture from the atmosphere, is excessive and incurable. The great primary cost of such houses is only equalled by the heavy outlay for maintenance. Further, cement for concrete is dear and scarce, and in some places, transit is prohibitive, both in time and expense. What, then is the alternative?

Our native raw material is clay. The value of clay has not increased, nor is it likely to appreciate. It is true that very many brick and tile works are derelict, having been commandeered for forage stores, &c., but burned clay cavity blocks *are* available in considerable quantities: and are being made, better, and more adapted to every building requirement, than ever before, in standardised forms and sizes. A hollow block, say 12 in. by 9 in. by 6 in. is equivalent to fully five ordinary bricks, but can be fixed in one-third of the time; or even less, if a labourer places it in position ready for the bricklayer to set it. A hollow block, 12 in. by 9 in. by 4½ in. is equivalent to four bricks; but the saving in cement for the joints is quite 66 per cent. and in labour of setting over one-half. In freight charges there is an economy of two-fifths, and other savings are effected. Schemes for housing have been held up because timber for supporting slates or tiles is not available; but flat roofs are constructed of hollow burned clay blocks, with slight reinforcement, at a minimum of expense. A parapet with pediment around the roof is by no means unsightly. The window openings are framed with hollow blocks, instead of wooden frames, and are glazed with metal casements and leaded lights. Your readers will therefore not be surprised to read that an official permit has been recently issued for the immediate erection of a colony of such houses for the accommodation of operatives at an aircraft factory, and they may rest assured that the authorities had to be satisfied that a minimum of labour would be employed, and delay eliminated. As it has been proved that this method of building is far cheaper, even than wood, let me point out how best to make use of it under present conditions! I have ascertained that a shell building can be erected for dining or sleeping purposes, say 60 feet by 25 ft. This skeleton can be so designed as to be afterwards fitted with interior details to form two complete cottages of five rooms each. The shell costs 300*l*., and the subsequent alterations 250*l*. Ultimately, for 550*l*. two cottages are acquired: but, at present, the owner of a works is called upon for only 300*l*. An important consideration is that such standarised burned clay cavity blocks can be made in any brick and tile works where suitable clay is available.

Yours faithfully,

PHILADELPHIAN.

DRAUGHTSMEN.

TO THE EDITOR OF ENGINEERING.

SIR,—In the correspondence under this heading various draughtsmen have pointed out some of the advantages of registering as a trade union.

As a referendum is to be taken in the association on this question it might help us to come to a proper decision if we look at the attitude of other brain workers in relation to this matter.

The Association of Electrical Station Employees, who, incidentally, talk quite a lot about status and education, went to sleep on the question of wages, and only wakened up when some of their members left them and joined the E.T.U., who at once obtained for them an increase of wages.

The Law Clerks Friendly Society has made such feeble efforts, that "A Thirty Years' Managing Clerk" writes to an important paper stating that in spite of private study, university lectures and experience which has enabled them to do their work without supervision, and to be in many cases as capable as their employers, only a few of them have had increases of wages, and the majority no increase since the war began. Yet many of them are not getting the wages of skilled labourers. He appeals, finally, for the creation of a strong trade union.

The salesmen and warehousemen in a large commercial centre in the first year of the war had their wages reduced by one-third and one-half; they worked consistent overtime in order to get through the work which had previously been done by the men who joined the forces. Their association was impotent, and it was only by correspondence in the local press that they were able to voice their grievances.

The National Union of Clerks has a very good record when compared to the Scottish Clerks' Association. So good that the chemists employed by a large corporation as well as other technical men have joined them.

Some of the colliery managers, instead of forming an association, invited the Miners' Union to organise them into a trade union.

There are, no doubt, numerous other examples of similar nature that could be given which would prove that the days of mutual admiration associations are of the past, and that the future is for the trade union which adopt those methods that command respect.

To some of our members who look with suspicion on any form of trade union activity, I may point out that the policy of the members is such as they like to make it, and that the aggressive militant attitude of the doctors at the time of the passing of the National Health Insurance Act, which one feels tempted to call anti-social, will never be adopted if they take a really serious interest in the work of the association and attend their branch meetings.

I remain, dear Sir, yours faithfully,

"STAFFORD SENIOR."

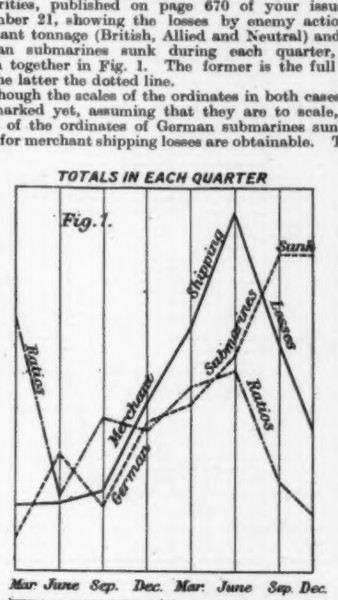
January 1, 1918.

SUBMARINE WAR.

TO THE EDITOR OF ENGINEERING.

SIR,—The interesting charts supplied by the naval authorities, published on page 670 of your issue of December 21, showing the losses by enemy action of merchant tonnage (British, Allied and Neutral) and the German submarines sunk during each quarter, are shown together in Fig. 1. The former is the full line and the latter the dotted line.

Although the scales of the ordinates in both cases are not marked yet, assuming that they are to scale, the ratios of the ordinates of German submarines sunk to those for merchant shipping losses are obtainable. These



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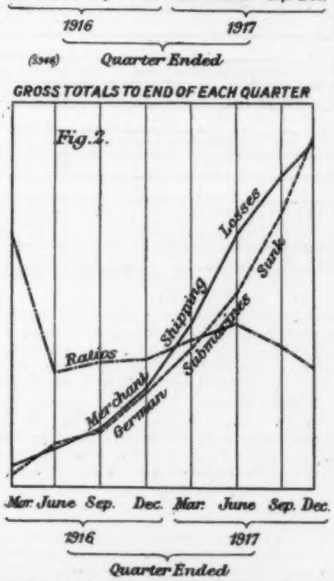


are shown in the dot-dash line and indicate that the best relative results have been obtained in the last quarter.

By adding the ordinates for each quarter the gross totals to the end of each quarter have been obtained. These are shown in Fig. 2, and indicate that the merchant tonnage losses have been increasing in a *decreasing* ratio since the June, 1917, quarter, while the German submarines sunk have been increasing in an *increasing* ratio since September, 1916.

The ratio curve indicates that the general trend from June, 1916, to June, 1917, was against us, but has now been reduced to about that of September, 1916.

Yours faithfully,

HENRY G. LLOYD, M.Inst.C.E.

44, Guilford-avenue, Surbiton, December 24, 1917.

AIRCRAFT CONSTRUCTION.

TO THE EDITOR OF ENGINEERING.

SIR,—I shall be obliged if you will invite opinion on the following problematical case in aircraft construction—not a very important point in itself, but in these times an interesting question when we want to increase outturn and avoid unnecessary corrections and friction.

A centre plane and a top plane are found on erection to have an excess space of ¼ in. where they meet. It is proposed to remedy this by opening the fabric and fixing outside the box rib of the top plane a piece of 3-ply ¼-in. thick.

Since variation of velocity V required to fly the machine is expressed by formula

$$V \propto \sqrt{\frac{W}{A}}$$

when W = weight of machine and A = area of planes, a similar result will ensue whether the area of plane is practically diminished through increased slip of air or whether weight is increased by adding extra material.

In each case a very small increase of velocity is required for horizontal flight which will require a very small increase of engine power and consequently leave a very slightly diminished engine power for climbing. The effect of increasing the weight can easily be calculated, but to measure the effect of increased air slip requires experiment, and perhaps some who have devoted considerable time to experimenting will give their opinion.

D. GEORGE, Assoc.M.Inst.C.E.,
Examiner, A.I.D.

7, Stanhope-terrace, Hyde Park, December 26.

THE MILITARY AUTHORITIES AND ENGINEERS.

TO THE EDITOR OF ENGINEERING.

SIR,—It is a little comforting to read through the somewhat overdue statement by Dr. Tudsbery in the ENGINEERING of December 21.

I have seen many a student of the Institution of Civil Engineers, and even one or two young A.M.I.C.E.'s, as privates in infantry units, employed in shoving barrows, shovelling coals or even washing and cleaning lavatories in the barracks. Applications for transfer to technical units such as R.E., A.O.C., Transport and Air Service, were sternly discouraged and even despised by company and commanding officers alike.

After such experiences, could we take it from the belated and nevertheless welcome statement of Dr. Tudsbery, that he is willing to champion and back up the applications for transfer from infantry to more suitable or professional or trade units as they are popularly known, from those connected with the Institution?

Surely such action on the part of this premier Institution of Engineers is not too much to be expected, when compared to what the apparently more powerful—probably because more numerous—trade unions are doing, viz., protecting both members and apprentices from being called up!

Your obedient servant,

A. S. RAM.

25, Croft-terrace, Jarrow, December 26, 1917.

"ISHERWOOD" SYSTEM OF SHIP CONSTRUCTION.—Mr. J. W. Isherwood, 4, Lloyd's-avenue, E.C. 3, states that the present year has been very productive of new tonnage in this country and abroad, and the "Isherwood" system, despite the almost abolition of building for private ownership, has gained a step further in the number of ships contracted for in one year. No less than 180 vessels, aggregating in deadweight carrying capacity about 1,334,000 tons, have been placed since the end of 1916. The grand total now stands at 800 vessels, aggregating 6,000,000 tons deadweight carrying capacity, as against 6 vessels, aggregating 31,608 tons in 1908. Of the 800 ships referred to, there are 386 general cargo vessels, colliers and ore steamers, and passenger vessels aggregating 2,891,600 tons deadweight carrying capacity, 24 Great Lakes freighters for 279,600 tons, 310 oil-tank steamers for 2,800,000 tons, 77 barges for 26,800 tons, 2 dredgers for 760 gross register tons, and 1 trawler for 570 gross register tons. The use of the system is greatly on the increase in the United States and in Japan.

NORWEGIAN IRON INDUSTRY.—The present situation has taught Norway how dangerous it is to be entirely dependent on foreign supplies of pig-iron, steel and steel plates, says the *Anglo-Norwegian Trade Journal*. The problem has been under consideration for some time, and one of the chief points to be settled was the geographical position of the new works. Opinions were divided between Christiania, Drammen and Christiansand. We understand that the neighbourhood of Christiania has been definitely chosen. Meanwhile other groups have been at work. A number of Stavanger people, working in connection with a large English company, have formulated plans for works at Straumpol in Tysfjorden, near Narvik, for the production of 250,000 tons of pig-iron annually and for the provision of a large rolling-mill. The close proximity of Narvik, which is the shipping port for Swedish ore, and also to Kirkenæs, the shipping port for the best Norwegian ore, are, of course, obvious advantages, but in addition to this Straumpol is reported to be a natural harbour with good industrial sites, having easy access to water power. The transportation of coal from England would be cheap, but beyond this the geographical position in relation to Spitzbergen should not be overlooked, seeing that a Norwegian group is now working energetically to develop the Spitzbergen coalfields. The total capital required is estimated at 22,500,000 kroner.

FOREIGN ENGINEERING PROJECTS.

WE give below a few data on several foreign engineering projects, taken from *The Board of Trade Journal*. Further information on these projects can be obtained from the Department of Commercial Intelligence, 73, Basinghall-street, London, E.C. 2.

Spain.—The *Gaceta de Madrid* notifies that tenders will be opened at the "Direccion-General de Obras Públicas, Ministerio de Fomento," Madrid, on March 9 next, for the construction and working, for a period of ninety-nine years, of a secondary railway from Cangas de Tineo to Pravia, *via* Cornellana. The capital fixed for the undertaking is 15,739,824 pesetas, on which interest not exceeding 5 per cent. per annum will be guaranteed by the State. The minimum rolling-stock required to commence the working of the line will be 6 locomotives, 20 passenger coaches, and 91 goods wagons. An option on the concession is held by Don Emeterio Ayesta de Zobaleta. Construction work must be begun within three months of the official notification of the award of the concession, and completed within four years.

Greece.—The Acting British Consul at Piræus has forwarded a copy of the Greek Government *Gazette* (No. 234) of October 24/November 6, containing the text of an agreement, in the French language, made between the Greek Government and the Société des Chemins de fer Helléniques for the carrying out of works of consolidation and improvement on various parts of the Piræus-Larissa-Papapouli line, and for the supply of plant and material. The sum of 9,500,000 drachmai has been allotted for this work. Included in the agreement is a schedule of the various materials required.

Ecuador.—The *Registro Oficial*, Quito, publishes a Decree authorising the Ecuadorean Government to grant a concession, by means of a call for tenders from national or foreign enterprises, for the construction of a branch railway from the station of San Juan to the town of Guaranda. This branch will connect up with the Babahoyo Railway, which is now under construction. The Decree allots the proceeds of certain taxes to meet the cost of construction of the new line, and empowers the Government to raise a loan, under their guarantee, to facilitate the carrying out of the works. The projected line will be surveyed by an engineer nominated by the Ministry of Public Works.

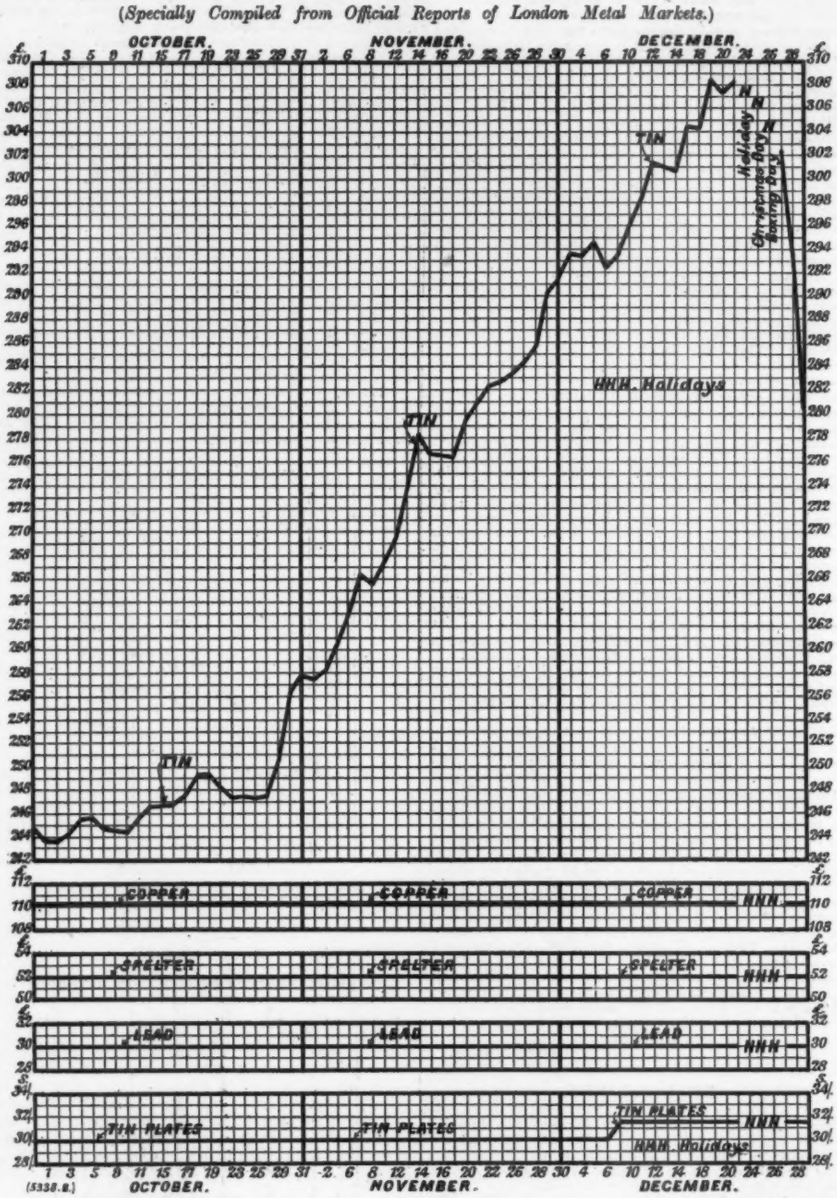
Venezuela.—The *Gaceta Oficial*, Caracas, publishes the text of a contract entered into between the Venezuelan "Ministerio de Fomento" and Elias Rodriguez González for the working of two coal mines situated in the El Pilar Municipality, State of Sucre, the Government leasing the deposits for a period of thirty years. The concessionaire must commence the working of the mines within three years from the date of the approval of the contract. For the lease of the mines the concessionaire will be required to pay 2 bolivars (1*s.* 7*d.*) in respect of every metric ton of coal produced. In accordance with the provisions of Article 92 of the Venezuelan Mining Law, the concessionaire will be able to import free of duty the machinery, supplies and accessories required for the working of the mines. He will also have the right to establish railway connections and to construct wharves at the port of shipment.

"MUNRO'S MARINE ENGINEERS' ANNUAL."—We have received a copy of this annual, which is compiled and arranged by Messrs. James K. Munro, and is issued at the price of 1*s.* 6*d.* net by Messrs. James Munro and Co., Limited, Glasgow. It contains, besides a monthly diary and blank tabular forms for private log notations and speed records, mathematical data, illustrated articles on marine engines, turbines, transmission gear, boilers, &c., and information of general interest.

CONTROL OF UNITED STATES EXPORTS.—Control over the entire export traffic of the Eastern Railroads of the United States in the unmanufactured forms of iron and steel, including billets, bars, plates, scrap and pig-iron (except for the United States Government) was, on December 4, as a war emergency measure, placed in the hands of a committee of seven railroad officers, representing the Atlantic ports from Boston, Mass., to Norfolk, Va. The headquarters of the committee will be located in the City Investing Building, 165, Broadway, New York City, adjoining the offices occupied by the representatives of the Allied Governments of Europe who are in charge of the purchase and transportation of munitions from the United States. Ultimately it is planned to place this committee in charge of all overseas traffic of the Eastern Railroads, not only in iron and steel, but all other descriptions, including that of the United States Government, with the approval of the Federal authorities. Mr. George D. Ogden, freight traffic manager of the Pennsylvania Railroad, has been appointed chairman. Mr. Ogden has also been appointed agent, with respect to overseas traffic, of the General Operating Committee of the Eastern Railroads, which has been organised at Pittsburgh for the purpose of pooling the facilities of those railroads and operating them as a unit. Arrangements have been made by the various railroads concerned to relieve the members of the committee from their ordinary duties, in order to enable them to render continuous service with the committee as long as this work shall continue. Officially, the new committee will be designated "Export Division-General Operating Committee, Eastern Railroads." The new committee, in exercising control of overseas traffic, will co-operate fully with the agents of the allied Powers and the United States Government in the effort to secure the best possible practical results in the rail transportation, from the interior to the seaboard, of export freight.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN PRICES OF METALS.

(Specially Compiled from Official Reports of London Metal Markets.)



NOTE.—In the diagram above the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange, as far as they have been reported, for "fine foreign" and "standard" metal respectively. The prices shown for lead are for English metal, whilst those for spelter are for American metal. The prices are per ton. The price of tin-plates is per box of I.C. cokes free on board at Welsh ports. Each vertical line in the diagram represents a market-day, and the horizontal lines represent 1*l.* each, except in the case of the diagram relating to tin-plates, where they represent 1*s.* each. On July 7, 1916, the Minister of Munitions issued a list of maximum prices and regulations governing the dealing in certain metals, &c.; thus the price of hematite pig was fixed at 6*l.* 2*s.* 6*d.*, Scotch at 5*l.* 14*s.*, and Cleveland at 4*l.* 11*s.* 6*d.* per ton. Ship-plates were priced at 11*l.* 10*s.*, and heavy steel rails at 10*l.* 17*s.* 6*d.* per ton. These quotations are still in force. (For official regulations see page 45, vol. cii.)

CRUDE SOLVENT NAPHTHA, SOLVENT NAPHTHA AND HEAVY NAPHTHA.—The Minister of Munitions has ordered the following: No person shall, as from the 10th inst., until further notice, supply to any persons, or take, or accept, or attempt to obtain delivery of any crude solvent naphtha, solvent naphtha or heavy naphtha, except under and in accordance with the terms and conditions of a licence issued by or under the authority of the Minister of Munitions. All persons engaged in producing, treating, distributing, storing, selling or dealing in these substances shall make returns with regard to their businesses as may be required by or under the authority of the Minister of Munitions. For all purposes of this Order the expressions "crude solvent naphtha," &c., shall mean the substances obtained during distillation of coal tar or extracted from coal-gas. All applications in reference to this Order should be addressed to the Director of Raw Materials Supply, Ministry of Munitions, Department of Explosives Supply, Storey's Gate, Westminster, S.W. 1.

THE MINIMUM HEAT CAPACITY OF WATER.—In order to determine the temperature at which the heat capacity of water has its lowest value, L. von Pfaundler (Sitzberichte Wiener Akademie, 1916, 2A vol. cxx, page 875) took two calorimeters, equal in all respects, and heated them up gradually in steps of 10 deg. C., starting the two calorimeters from different temperatures, however. The heat was electrical, and he determined the calories absorbed by the two calorimeters in the same experiment. In this way he ascertained that water has its minimum heat capacity between 30 deg. and 40 deg. C. In further experiments he interposed a thermopile between the two calorimeters and thus found that the exact temperature of the minimum was 35.5 deg.: this value agrees with that determined by Jaeger and Steinwehr at the Reichsanstalt.

SOME INSUFFICIENTLY CONSIDERED DETAILS OF SHIP CONSTRUCTION AND EQUIPMENT.*

By C. WALDIE CAIRNS, M.Sc., Member.

IT will be generally admitted that shipbuilding art and science have reached a fairly satisfactory position, though there must be possibilities, not yet fully realised in the more efficient application both of labour and present materials, towards the production of efficient vessels, and we hear more than rumours of new materials. No doubt, much useful information has yet to be obtained and disseminated as to the form best suited to any desired speed and deadweight, but in the main we may assert that the modern steamer generally "keeps right side up," and gets through the worst weather with fewer serious instances of strain, either to upper works or to bottom, than in the days when the registration societies were struggling with the problems arising from increase of size and of fullness of the ordinary cargo ship. The writer has no intention, in this contribution, of invading the domains of the naval architect in any of the important provinces mentioned, but wishes to direct attention to a number of items which, from his experiences with shipbuilders and ships, he judges receive somewhat scant attention in the ordinary cargo steamer equipment.

It is not suggested that all shipbuilders neglect all the items mentioned, attention to these details varies very much. The practice regarding some of these is excellent in certain yards, but the writer has seen important items overlooked in yards that, in most respects, are, at least, up-to-date. None of the items referred to account for much in total cost of a ship, but they may mean a great deal in relation to subsequent satisfaction, safe working or freedom from many irritating small repairs. Certain of them might well be the subjects of standardising agreements, or of a "Standard Fittings Specification," which would eliminate a slight advantage in the market that a "mean" yard may hold over a yard where quality is considered. Practice with regard to some fittings is not even sufficiently standardised in individual yards, choice of details being occasionally left to foremen, apparently without any standard arrangement to be complied with.

The necessary minimum scantlings and ground and mooring tackle are already imposed on builders in the rules of Classification Societies. It would be a convenience to owners of ships, and no doubt to builders also, if a well-considered minimum standard in other details of equipment could be formulated, or even a series of grades of equipment which could be referred to by distinguishing titles. There might, for instance, be a minimum "Coasting Collier Equipment" or "Class I," and "Class 2" "Coasting Collier Equipment"—similarly, one or more grades of "Baltic Trade Equipment" of "Collier and Ore Trade Equipment," of "River Plate Trade Equipment," of "Eastern Trade Equipment." Some of these would differ comparatively little in main features.

Possibly, the commencement made by this Institution on The North East Coast Institution Engine Specification, which is already leading to national developments, may, by its example, induce this or another institution to make an effort to standardise good practice in some of the details that will be referred to. It may be urged:—Why not specify what you think good in the ships in which you are concerned, and let others put up with what they get? Well, laying aside many strong reasons and giving the selfish one, good details are much more cheaply obtained when they are general practice than when they have to be specially bargained for, and perhaps specially designed for one's own ships.

* Paper read before the North-East Coast Institution of Engineers and Shipbuilders, at Newcastle-on-Tyne. December 21, 1917.

Chain Cables.—One point regarding these concerns the shipbuilder. Possibly the shipbuilder will insist that the point rather concerns the owner and his advisers, but as it becomes apparent on design of the hawse pipe, the shipbuilder has first cognisance of it. This point is, that with most stockless anchors, in any but the smallest ships, the joining shackle between anchor shackle and end link of the cable is, with the anchors in the "stowed" position, so far down in the pipe that it is impossible to knock out the shackle pin, without lowering the anchor out of the hawse pipe. If this were only required in dry dock, little harm would result, but as it is necessary, under certain conditions, to moor ships by the main cables, easy access to an end-shackle is of importance. This is easily arranged for by the provision of a short length of cable, say 4 ft. to 8 ft. long, according to need, on each anchor, thus bringing the shackle into an accessible position above deck, where, after the anchor has been "hung off," the shackle pin can be easily driven out.

The next point, regarding cables, is to some extent a reflection on the makers. Cable makers are supposed to work to some standard as to dimensions of cable links, end links and joining shackles: presumably, again, this is the "Admiralty Cable Scale," of which the windlass makers issue useful tabular particulars. The form of certificate issued from the proving houses records the "length and breadth of links, but no report is made of variation among lengths of links, nor is any permissible "degree of tolerance" stated on the certificate.

Correct forms of links, with consequent correct pitch of links, is of the greatest importance for reliable operation of the windlass. Cable-lifters can, of course, be designed for any pitch of chain, but if the pitches are not reasonably equal throughout a ship's equipment, "jumping" of the cable over the "lifters" may ensue, and undue wear and tear of the "whelps" will certainly occur.

Reference to this matter is not to be considered "finicking" or pedantic. A case came under the notice of the writer during the last three years, where a large part of the cable equipment of a new steamer had to be replaced for this reason, and within the last few months he took an opportunity of checking over five lengths, all just delivered from one maker, and found the following variation in "length overall of ten links" when ranged by hand in dry dock bottom:—

		Ft.	In.
No. 1	Length	6	9¼
No. 2	„	6	6½
No. 3	„	6	8
No. 4	„	6	6
No. 5	„	6	9

Windlass makers probably do not expect perfection of pitching, and cable makers certainly cannot attain it, but some "limits" might well be agreed, and test house officials might then be directed to check lengths of cable when under light tension and record on the certificate the correctness of end links and the maximum and minimum "lengths over ten links," with power to reject cables not coming within agreed limits of variation.

Mooring and Warping Arrangements.—The needs and requirements of our sailor friends deserve the fullest attention in this matter, and if their ideas appear to have expanded recently in connection with the fittings deemed requisite on even "common tramps," we should remember that the dimensions of such ships have continued to grow in most trades, and that at the same time the lengths of jetties and berths have not been growing proportionately. Hence methods of mooring and of handling warps that were possible under bygone conditions, may no longer be applicable—for instance, hauling lines often now have to be run out from positions in the middle half-length of a steamer, instead of over bow or stern, as on shorter ships or at berths of great length. Further, at coal tips, or other crowded berths, ships are often "scarphed," or laid with their lengths partly overlapping, making safe and handy means of working "breast ropes" necessary. It will be judged from this that all requirements are not fulfilled by "quick-warping drums" on windlass and a warping winch on the poop, useful and necessary as these helps are.

Fairlead sheaves on comparatively light cast iron stools are often fitted in the vicinity of windlass and of after winches. These are usually strong enough to act as guides or supports for warping wires between warping chocks and the winch or windlass, provided the angle between the two directions of the wire is nearly 180 deg., and these fairleads are useful in their way, but what is really required in addition, is the placing of strong warping guides on deck or on stools, between the winches, and in other positions to deal with breast ropes. In some positions these ropes may have to be led with parts nearly, or quite, parallel, so applying to the fairlead a load equal to double the tension of the rope.

These warping guides would not only save time in working the ship, but would minimise the number of occasions when snatch blocks—easily strained, and always destructive to the ship's wires—have to be used. The arrangement suggested is shown in Fig. 1.

It will be noticed that fairleads are indicated at the ship's side, as well as the extra fairleads between the winches. In too many cases horn fairleads only are fitted at the side: these fairleads should be of ample strength, equal to the old horn fairleads.

It is also important that bitts or bollads should be so placed that the hauling line passes close to them between the fairlead at the ship's side and the fairlead at the winches, as this enables "stoppers" to be so used as to avoid loss of tautness of line whilst transferring from winch drum to bitts. For all fairleads for warps, &c., there is a healthy tendency towards the use of sheaves of large diameter, and in most cases these sheaves are now provided with brass bushes.

The warping fairlead of old form, Fig. 2, is still common. In this type, bushing of the roller or sheave is not sufficient, a brass washer should be provided at top and bottom also, otherwise the roller will almost invariably be found to be "rusted up solid" before the ship is many months old.

There are, however, several special forms of fairleads on the market, and already widely used, their cost differs but little from the common form, and as they are all self-lubricating and fitted with sheaves of large diameter, and of good form, they are a distinct advantage to a ship in saving wear and tear of hauling lines. A point to be borne in mind, however, is that they give somewhat poor guidance to a wire led upwards steeply from ship to quay: some special arrangement may be necessary if much work of that kind is expected. These conditions rule in Panama Canal locks and have made necessary a form of mooring chock, which will prove useful both under such conditions as to quays and where, as sometimes happens, a line has to be led from a loaded ship up to a light ship lying alongside.

Cargo Gear.—One always feels that in a well-organised world ships would not require to be fitted with a heavy and expensive outfit of cargo gear, to spend probably four-fifths of its time as ballast, or as to much idle weight to be carried round at sea. However, while there remain

Fig. 1. PROPOSED FAIRLEAD BETWEEN WINCHES.

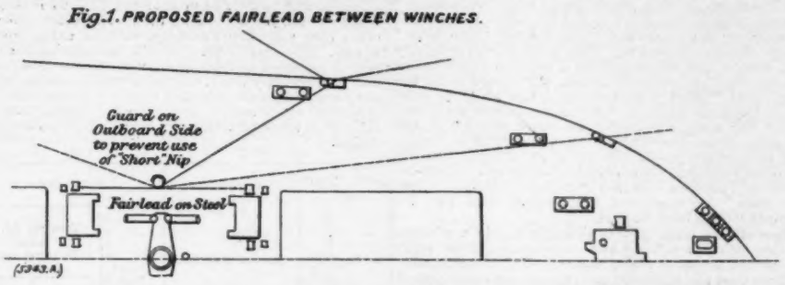


Fig. 2. OLD TYPE FAIRLEADS. ALL DESTRUCTIVE TO WIRES

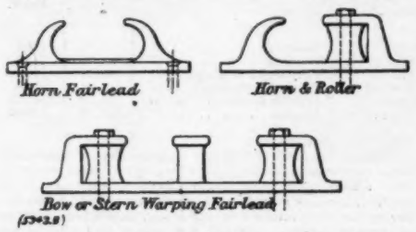


Fig. 3. NATURE OF TEST LOAD REFERRED TO ON TEST CERTIFICATES FOR BLOCKS.

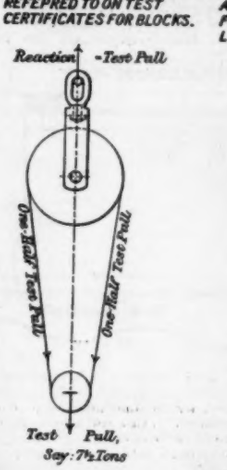


Fig. 5. 16" CARGO BLOCK, AS USUALLY SUPPLIED FOR SPECIFIED 5 TON LIFTS.

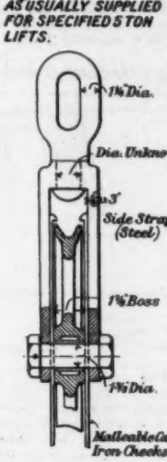
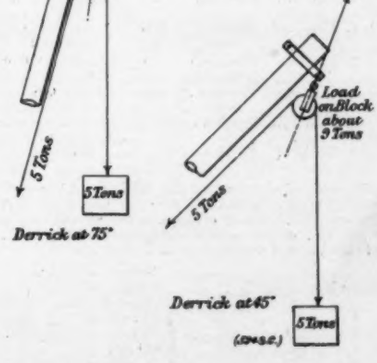


Fig. 4. NATURE OF LOADING OF BLOCK WHEN IN USE.



ports where vessels may be asked to lie—as frequently at Hull, Rotterdam and elsewhere—with lighters at each side to receive cargo worked out by the ship's own winches, or ports in which, although quay berths are provided, enterprise does not "run to" cranes—ships other than those serving special trades must continue to carry about with them anything from four to thirty winches, with, in the latter case, a forest of masts, derricks, and derrick posts to enable them to be utilised.

The elementary theory, as to loads on derricks, spans, runners, blocks, &c., has been written about, calculated about, and reduced to handy form in numerous text books—some even specially written for easy comprehension by the least mathematical of ship's officers. In spite of this it is rare to find a sound view of cargo gear taken, even in the drawing office. In many yards cargo gear appears to have "just grown" by some system of "trial and error," presided over by the foreman blacksmith. This man is, in most cases, a good man at his trade, but it does not follow that he is consequently an authority on determining dimensions or stresses.

The writer remembers the case of one yard, where, repenting of these ways, the drawing office was set to design derrick fittings, and a quite neat design was evolved. Unfortunately, the designer forgot that derricks are ever swung out over the side, and the span-head connections, while fairly satisfactory for the direct tension produced by a fore-and-aft position of derrick, were stressed to over 16 tons per sq. in. by the bending strain produced by the thwartship direction of spans when the derricks were swung out. Probably the foreman blacksmith's "eye," without calculation, would have been safer than this incomplete consideration.

Another example of the insufficient consideration given to cargo gear is evident in the choice usually made of cargo blocks for derrick ends.

Supposing a 5-ton lift is required, the experts who order, and the makers who supply the blocks, usually consider they have behaved liberally by arranging for a block tested to 7½ or perhaps 10 tons, and the unsuspecting sailorman and stevedore are expected to go happily and trustfully about their business of lifting a 5-ton load. But what is the real margin here? First of all, considering dead load effects, the block under a 7½-ton test is loaded as in Fig. 3. When supporting a 5-ton load, in working positions, the method of application is quite different, and results in pressures on the pin and tension on the suspending eye amounting to from about 1.8 times the load with derrick at 45 deg. to 1.95 times the load with derrick at 75 deg. (see Fig. 4). So the margin of test load over working load, instead of being 50 per cent. or 100 per cent., has vanished, even if the working load is a dead load.

The test load on the block, having been carefully applied by a testing machine, was certainly a "dead load," producing stresses directly calculable by elementary methods. Working loads on cargo gear are, however, "live" loads—very much so. No matter how carefully they may be "picked up," there are invariably surgings and shocks produced in lowering and checking: by these the stresses are at least doubled, as compared with those produced by the "dead" loading arising from supporting the same weight at rest. This further discounts the utility of the test load, which, in reality stresses the block much lower than working conditions will.

There is no doubt that we are often saved from breakages of cargo gear by the fact that the system yields when a load is checked or surges, or drops after a check. This yielding is mainly from the elastic stretching of the material of the span, runner, and shrouds, along with the deflection of mast or derrick-post from the unstrained position. The importance of this yielding, as a means of modifying the severe effects of "impact," may be judged by the following comparison:—

Assume a load of 1 ton drops from rest, with a free fall of 1 inch before the cargo gear begins to check its descent. At the moment when the fall has been completely arrested the reaction of the cargo gear is as follows, varying with the amount of "give" of the gear:—

Yield of Point of Attachment of Load from First Check to Final Stoppage of Fall. In.	Reaction Stressing the Cargo Gear (1 Ton Load), Tons.
1	4.00
2	3.00
3	2.66
4	2.50
6	2.33
12	2.16

It will thus be seen how difficult it is to get the stresses down even to double the stress arising from a dead load of same weight.

Calculation of the expected yielding of the point of attachment would be somewhat tedious, especially as the bending of mast and stretch of shrouds is involved, but as a guide to the order of the dimensions involved it may be pointed out that the extension of 120 ft. of steel wire rope, when stressed up to 6 tons per square inch, is probably between ¼ in. and 1 in. This 120 ft. is mentioned as being the approximate total length of runner plus span, taking span as being carried down to cleats or bitts near the deck. If a manilla downhaul tackle is fitted, the yield will be much greater and the multiplication of nominal stress somewhat decreased.

The old Admiralty "tests and loads for chain" quoted in "Mackrow" gives figures on the following basis:—

1 in. chain—"breaking strain," 27 tons,
"proof strain," 12 tons,

and states that the "working strain" for crane chains, &c., should not exceed 2/9th the "breaking strain" or half the "proof strain."

It is to be noted that the stress on material, taken on the *sides* of chain links would thus be:—

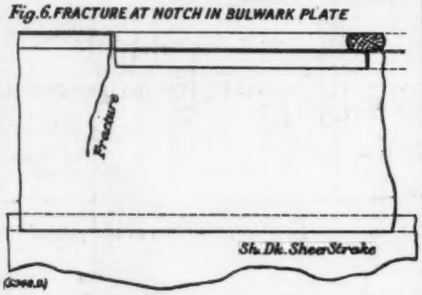
	Tons per square inch.	
At breaking load ...	17.2	38,500 lb./sq. in.
At proof load ...	7.63	17,100 lbs./sq. in.
At working load ...	3.81	8,550 lbs./sq. in.

The working load stress may appear high, but it must be remembered that a chain load is never reversed.

Presumably this refers to the best class of wrought iron, of which the breaking stress of the unworked material would be sensibly higher than the breaking stress of the chain on test. Even making allowance for such steel as is now used in blocks and other cargo gear forgings or stampings, in place of iron as in chain, it would not appear advisable to exceed these "calculated" stresses (that is calculated as if dead loads), particularly in view of the somewhat indeterminate "live load" effects already referred to. This much we can definitely say, that where we design for a nominal stress under "dead load" of about 3.8 tons per square inch, the "live load" effect will raise the actual stress at least up to the proof stress of 7.6 tons per square inch, and whilst the margin between the latter stress and the breaking stress of mild steel in either forgings or stampings is none too great, still less is the margin between the proof stress and the elastic limit excessive. It should never be forgotten that the "factor of safety," where live loads" are concerned, is not more than half its nominal "dead load" value.

Now all this cargo gear criticism is merely a mixture of elementary textbook and common-sense—or what the writer hopes is common-sense—but unfortunately he finds that the textbook and the common-sense points of view are not always applied to cargo blocks. The shipbuilder usually orders from manufacturers an outfit of ready-made blocks, tested to 5 tons, 7½ tons, or whatever occurs to him as a reasonable margin over the owner's desired "lifts." Manufacturers are not infallible either. In the case of one much patronised maker of blocks a request for drawings for inspection brought the reply, "Sorry, we have no drawings. Our work is all done to templates." In such a case there is always a fear that there never have been any drawings, or that ancient error has been copied from another manufacturer. Some alleged specialities are admittedly "designed" by copying those of other makers, mistakes included, without any questioning criticism on the part of the copyist.

Fig. 6. FRACTURE AT NOTCH IN BULWARK PLATE



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The writer has examined stresses of a cargo block dimensioned as in Fig. 5 on the previous page and found stresses per ton of load at eye (or what is the same, per ton load on pin) as follow:—

Part.	Nature of Stress.	Per Square Inch Stress per Ton Load at Eye.
1. Pin ...	Shearing ...	0.338 ton or 724 lb.
2. Pin ...	Bending taken $\frac{WL}{8}$	0.918 ton or 2,060 lb.
3. Pin ...	Pressure on bearing	869 lb.
4. Binding	Tension at pin-hole.	0.491 ton or 1,100 lb.
5. Oval eye	Tension on sides	0.4075 ton or 915 lb.
6. Neck of eye.	Tension	No data.

The makers' test load for this block is not known: the working load suggested is 5 tons: and after making allowance for method of application of working load, as per Fig. 4 the apparent stresses (leaving live load and shock out of account) are as follows:—

Stress No.	Stress or Load per Square Inch under Proposed Working Load.
1 ...	3.29 tons or 7,050 lbs.
2 ...	8.94 tons or 20,000 lbs.
3 ...	8,450 lbs.
4 ...	4.78 tons or 10,700 lbs.
5 ...	3.97 tons or 8,910 lbs.
6 ...	No data.

A double-sheave block proposed by makers for a test load of 20 tons, showed stresses under test load as in the next column. Stresses under working load are also tabulated, assuming working load half the test load and that, as is possible, the block is used combined either with a single or a double-sheaved block, the fall rope adding in the one case one-third, and in the other one-fourth to the load on pin and on eye.

It will be noticed that in a double block, whether coupled with another double block, or with a single block, the effect of the fall rope in reducing the margin between real effect of working load and the test load is much less than in the case of a single-sheave block already commented on. The writer submits that even allowing for the fact that the loading of blocks, like that of chains, is never reversed, some of the stresses tabulated are very much too high, both on test and on working loads, and especially with the working loads when in addition live load effects are kept in view.

One might examine the whole range of details of cargo gear and find much to criticise: probably in many cases stresses even above those tabulated could be discovered. It may be asked, "How are there so few accidents with cargo gear?" One help is that even where say 5-ton gear is specified, a ship may make many successive voyages with only 2½-ton or 3-ton lifts to make, and when a 5-ton lift is made, a distrustful chief officer will often take special precautions, such as using purchase blocks, preventers, &c. It will be admitted that if gear is installed as 5-ton gear, these precautions should not be necessary: a little care would ensure this at comparatively small expense, if good practice were, by a standard specification or otherwise, made common. Most of us know of accidents under present conditions of design.

Part.	Nature of Stress.	Stresses. Under Test (20 ton).	Tons per Sq. In. under Working Loads. With Single Block.	With Double Block.
Pin ..	Shearing	4.81	2.77	2.6
Pin ..	Bending	2.57	1.70	1.6
Pin ..	Pressure on bearing	2.86	1.90	1.79
Binding ..	Tension at pinhole	8.90	5.94	5.55
Oval eye ..	Tension in sides ..	10.00	6.70	6.25
Neck of eye	Tension	13.4	9.00	8.43

Meanwhile, may the writer suggest that a reasonable basis for stresses in cargo-gear forgings of steel would be that where loads in a single direction only are to be applied, stresses should not exceed a nominal 8,000 lbs. per square inch under working loads, that where reversal of stresses occurs, 5,000 lbs. per square inch should not be exceeded, and that both these figures should be reduced where sectional area of any part is less than 1 sq. in., or a part is less than ¾ in. thick. These stresses would allow some margin for live load effects, but parts subject to wear should, of course, be diminished in excess.

From this short consideration of stresses on cargo gear, the writer would like to pass to consider for a few minutes some points in cargo-gear arrangements. Many ship general arrangements, when examined, show a fore stay and a back stay to each lower mast, and it will generally be found that these stays have been taken into consideration in the staying of the mast against cargo loads.

In view of the fact that derricks, even where fitted in pairs, must swing across the centre, these stays have to be "let go" during working of cargo, unless work is never to be carried on simultaneously at two adjacent hatchways. These stays are useful to prevent undue vibration of the mast at sea, but they should never be counted on for cargo discharging purposes: the necessary support to the mast should be got by spreading out the lower ends of the shrouds sufficiently, and where 10-ton to 20-ton lifts have to be provided for by fitting additional shrouds for temporary use on the opposite side of the mast to the heavy lifting gear with their lower ends still further spread out. These will not seriously hamper discharging from adjacent hatchways, especially as during extra heavy lifts work in adj. cent hatches will generally be suspended.

A point about heavy lifting-gear sometimes neglected is that the step for the heavy derrick should be got as close in to the mast as possible, so that it may be, as directly as possible, under the point of suspension of the span at lower-mast head, otherwise the guying of the heavy derrick requires heavy tackle. Detail's of all this gear require careful consideration. Some of the commonly used arrangements of long links, shackles, &c., for span heads are not satisfactory, stresses being excessive in certain positions of the derrick.

Another important point with regard to cargo gear is the means for handling derrick spans. In some cases a purchase block is fitted above the derrick with a guide block on the cross-tree of the mast, forming a purchase tackle, the fall end of the same wire being led to belaying cleats or bitts about the base of the mast. To raise or lower the derrick in this way is rather a dangerous operation as the wire has to be "stoppered" and the end taken to the winch barrel or warping drum, and when the derrick has been lifted to somewhere above the desired position it has to be again stoppered, whilst the wire end is again made fast to cleats or bitts.

To avoid the danger and inconvenience of these operations a topping lift should be fitted to each derrick, the simplest arrangement consisting of a single part span passing over a guide block at the cross trees of the mast with a down-hauling tackle, either of light wire or of manilla connected to an eye in the span end, which is at the cross-trees when the derrick is down. With this arrangement the derrick can be lifted or lowered to any desired position and the working span fall then made fast to bitts or bollards.

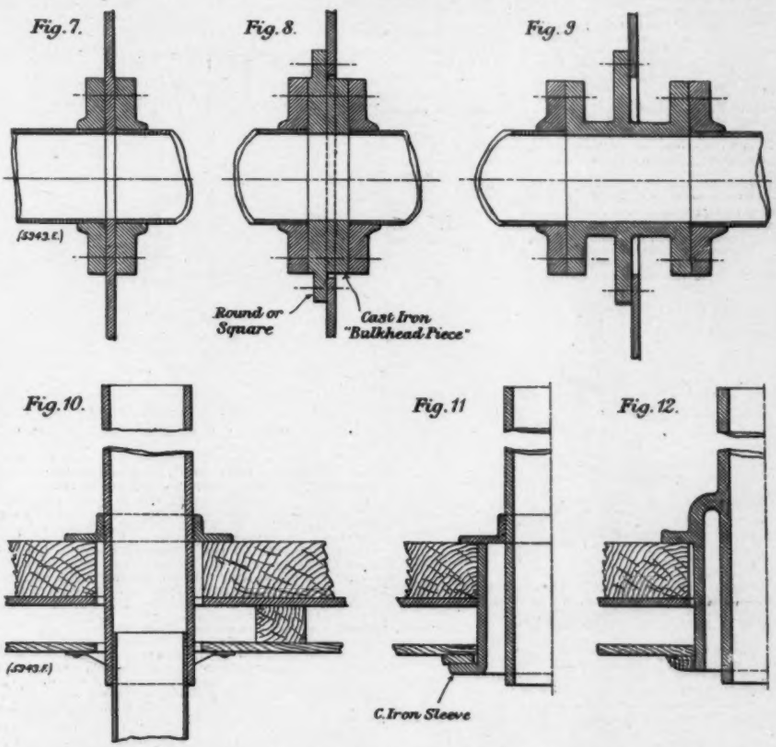
The writer feels that in touching on cargo gear he has

taken a bigger subject than can be reasonably dealt with as part of a general paper. There is undoubtedly room for an examination of the whole subject, and plenty of material for a long and important contribution to the proceedings of the Institution.

Erections, &c.—It will be remembered by many of the members that there was a time when so-called erections on a ship were practically neglected in strength calculations. It seemed to be taken for granted that because they were lightly constructed they did not take part in the straining of the ship.

Whilst shipbuilders and others neglected this, natural laws did not, with the result that these erections were subjected to stresses roughly proportioned to their distance from the neutral axis of the vessel, although possibly they did not add very much to the strength, in view of their lightness. The results showed themselves in various ways—upper decks tearing, houses working, and in some cases weakness showing on a strong deck at the abrupt end of a house which stiffened it locally.

In the main parts of the structure of a ship these bad effects are now prevented by suitable means, but there are some minor ways in which the operation of the laws of elasticity show themselves. The writer has in mind a case which he saw recently, where a bulwark plate was fitted abreast deck houses on a shelter deck ship. The



ends of the bulwark plates were shaped for sightliness, and there was no great indication of strain there. The upper edge of the plate, however, at about its mid-length had been stepped, so that a wood rail abreast the house might run with its top at the same level as the bulb-angle stiffener fitted on the remainder of the length of the top edge of the plate. There was thus an abrupt stoppage of the light bulb-angle in addition to the square cut in the plate edge: the consequent concentration of stresses in this corner has fractured the bulwark plate, as in Fig. 6.

It is also found that detached houses well above a shelter deck may acutely feel the straining of a ship in bad weather to the extent that the seams of their wooden top decks will cease to be watertight. These often take up again when bad weather and consequent straining and working of the ship cease. It seems evident that better arrangements on these house tops are necessary—possibly the addition of tieplates would be beneficial.

Another position in which house tops do not receive sufficient care in design occurs alongside engine casings. It is common here to attach beam ends to the engine casing side by simple lugs, or even by a strap piece bent at right angles, with a couple of rivets each way, the rivets through the casing side sometimes being so far from the beam that the connection lacks stiffness. A wood deck on such supports certainly does not get fair play, and would give much more satisfaction if a tieplate with angle to casing side were fitted fore and aft on top of the beams before laying any wood. The beams too would probably be better if somewhat stiffer than usual in such positions, and if fitted with small knee brackets. The writer's views on this matter are strengthened by his knowledge of the case of a ship in which such a deck is quite satisfactory on one side of the ship, and is very unsatisfactory on the other side: on the satisfactory side a steel bulkhead parallel to the casing forms an intermediate support for the beams, whilst the beams on the other side of the ship have no such support, there being on that side only a wood bulkhead. This plainly points to lack of stiffness of the beams being one of the principal causes of this deck leaking. There is, of course, not much weight on the deck above, but the beams and their connection evidently take part in the general working of the ship.

A reasonable camber on beams such as those supporting house tops is also desirable. The writer thinks that in many cases the camber of these is too flat. Boiler casing tops too should have very pronounced camber. It is common to see such tops built flat and ultimately sag somewhat, with consequent rapid corrosion.

Deck Machinery—Steam Pipes, &c.

Windlasses.—Better provision might well be made for means of closing the chain pipes through the windlass bedplate when a vessel gets away into deep water. If the windlass makers could give us a little higher lip on the chain pipes on the top of the bedplate to enable a canvas coat to be lashed to it and also to the cable, there would be more security against getting unnecessary water down into the chain lockers when the steamer "digs her nose into a head sea." At the present time makeshift methods of covering up the closing plate usually supplied for the top of these chain pipes with Portland cement are sometimes adopted. These methods would be more effective if the plate was so cut as to make a more complete closing and to drop a little way into the chain pipe and rest there on an internal lip.

Winches.—Shipbuilders are generally shy about lifting the winches high enough off decks to enable chipping and painting to be carried out underneath. Nine inches is a very moderate height for this purpose.

Hand Steering Gear.—Most cargo ships with steering engine amidships are still fitted with a hand steering gear aft. This is in practically all cases so slow and clumsy as to be almost useless. In some cases reported to the writer where, through breaking of steering chains, the hand gear aft has had to be put into operation, a smash-up of the gear has been the result. Possibly straining during coupling up with the rudder lashing about may have had something to do with the trouble. At the same time the writer was never very strongly impressed by the amount or disposition of material in these gears: the nuts always appear so very weak in proportion to the large screws employed.

Some builders have, in recent examples, abolished these hand gears in favour of an arrangement for steering by means of the after winches, and with a good arrangement this would appear to the writer likely to produce better control of the ship than could be maintained by even a large number of men at the hand wheel, which must really be too slow for effective control, whether the ship is under her own steam, or broken down and in tow.

Probably an efficient arrangement of this kind would obtain sanction as an alternative method of steering from the registration societies. This system seems worth working out.

Steam and exhaust pipes.—Very objectionable methods of carrying steam and exhaust pipes through casing sides, decks and casing tops are still sometimes employed. The worst of these methods is the "sandwich" joint (see Fig. 7). A less objectionable method (Fig. 8) is sometimes employed, but in view of the fact that leakage from this will generally blow on to the plating, this is not much better than the "sandwich" joint. The best arrangement the writer knows of is shown in Fig. 9.

This should be employed wherever space permits. This arrangement permits the use of bolts instead of studs, and keeps the joints at such a distance from the plating, that if a leak has to go uncorrected for some time the plating, at any rate, does not suffer, whilst the fact that heat does not so readily get from the pipe and its contents to the plating also helps to keep down corrosion.

Stove Pipes.—Lack of thought is often shown in the fittings employed for carrying stove pipes through wood decks or wood sheathing. If you inquire regarding this matter in the drawing office or in the yard manager's room, you generally receive a most confident assurance that an excellent system is employed, and possibly a very good sketch may be submitted. If, however, you follow the matter up in the yard, you often find that a most rudimentary fitting consisting of an iron coaming pipe with a narrow iron flange ring, as in Fig. 10, is being fitted by the carpenter. If he is a thoughtful tradesman, and if the flange on the coaming pipe provided by the store happens to be large enough to permit, he will possibly cut the wood of the deck or the sheathing ¼ in. each side larger than the pipe, and if he happens to think of the matter, he may put a strip or two of asbestos millboard in the space thus formed. The chances are, however, that if this is a wood deck, there is nothing to prevent the asbestos from dropping through, and the chances are still greater than if the stove pipe passes through a space in which there is a wood ceiling and beam casings below the wooden deck, the spigot will not be long enough to come well through both the deck and the ceiling, so that there is nothing but the thin and easily corroded stove pipe between the hot gases and the space at the back of the ceiling. A really good system requires to be worked out and made universal for stove pipe coamings.

The writer ventures to put forward for consideration the methods shown in Figs. 11 and 12. These are probably old, and possibly some member may have a still better suggestion to put forward. Such methods would save marine superintendents from having to spend time on such petty details as stove pipes both when the ship is building and at various times during repairs when what may have been a fairly safe method of connecting up stove pipes to coaming in the original construction of the ship is in danger of being perverted into something dangerous by the misplaced ingenuity of the repairers' joiners and plumbers.

Small Fittings.—Perhaps no item among the smaller details of ship's equipment causes more trouble during the lifetime of a ship than port lights or scuttles. As a mechanical contrivance the ordinary side scuttle leaves much to be desired. Tightening is effected by a single screw, the balancing reaction at the opposite side of the glass frame being the inadjustable support of a hinge bolt. Hence, if the rubber packing is hard and rather thick, the means taken by "Jack" to cure the leak that is soaking his surroundings with sea-water—putting the poker-end or a spanner into the loop of the nut, and heaving up tight—is likely to result in a serious straining of the glass frame. Another frequent cause of strain is the effect of a gradual filling up by successive paintings of the slight clearance between spigot part of glass frame and inner diameter of the cast-iron or main frame. Here "Jack" never dreams of the cause of the trouble, and "heaves her up tight,"—tight enough, but not watertight.

No care in design will ever make a sidelight absolutely "fool-proof." They would certainly be more satisfactory if a hinged screw were fitted on the hinge pin, with sufficient play in the hinge eyes to permit the screw to apply some pressure. The writer thinks this system was at one time on the market, but did not "catch on." A double-jointed hinge would be rather better, with a similar screw, as it would not depend on any play in hinge eyes.

To withstand blows of seas and pressure from fenders, &c., sidelight frames applied by some builders to forecastle and poop sides should be much stronger, particularly when, as usual in cargo-boat practice, cast-iron flanges are used. Any guidance specification in referring to this matter might well stipulate a minimum weight of brass for the glass frame, and of cast-iron for the main flange, as well as giving sections of these parts and thickness of glass.

A paper of this length cannot by any means exhaust the list of matters requiring greater attention in ship design and construction. Possibly much that is taken for granted and carried out without question under present practice would not stand criticism if looked into. Take, for instance, a hatch coaming with heavy flange on the lower edge. Considered as a girder, its section is appallingly inefficient, its neutral axis is most unsuitably placed, and the edge which has to stand compressional stress is of the poorest form for the purpose, the hollow half round moulding being useless except to prevent chafing of the tarpaulin; its rivets are not even in shear to enable it to help the plate efficiently.

Recently builders and the registration societies after a Royal Commission woke up, and have applied bulb angle stiffeners to coamings in certain cases, in a position that helps against the compressive stress, both by raising the neutral axis and by adding lateral stiffness to the plate. Possibly there are other details where equally radical treatment would be justified, and this paper will not have been useless if it leads other members, in the discussion which the writer hopes to evoke, to draw attention to, and, if possible, indicate the necessary corrections for such errors in practice.

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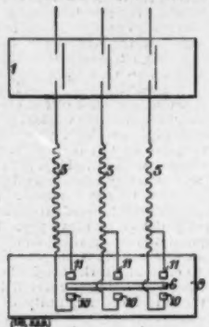
ELECTRICAL APPARATUS.

110,259. W. J. Howard, Sheffield, and A. Reyrolle and Co., Limited, Hebburn-on-Tyne. Electric Transformers. (2 *Figs.*) January 22, 1917.—In the case where two voltages are required from a three-phase static transformer it is known practise to tap the primaries and to employ two control switches or automatic circuit breakers so interlocked that only one can be closed at a time, these switches being so connected up that one of them controls the whole of the primaries whilst the other controls only the tapped parts. In this invention only a single control switch is employed, and it is interlocked with a change-over switch, the movable element of which is the common neutral conductor. This is diagrammatically represented in the drawing in which 1 is the single control switch. 9 is the change



over switch, the movable element 6 of which is the common neutral conductor. The said movable element makes contact alternatively with the fixed contacts 10, 10, 10, in which case the whole of the windings 5 are in circuit, and with the fixed contacts 11, 11, 11, in which case only part of the windings are in circuit. It will be seen that in the case of this invention two voltages are obtained, but it will be readily understood that to obtain a larger number of voltages all that has to be done is to increase the number of tappings and of the corresponding necessary parts. The control switches and the change-over switches used in this invention are preferably oil-break switches, and so interlocked that the change-over switch can only be operated when the control switch is open. (*Accepted October* 24, 1917.)

GAS ENGINES, PRODUCERS, HOLDERS, &c.

110,045. Wolseley Motors, Limited, J. D. Pitt and H. G. Lester, Birmingham. Internal-Combustion Engines. (5 *Figs.*) November 8, 1916.—In reversing the direction of rotation of the crankshaft of an internal-combustion engine, in which the sequence in which the cranks are operated by the pistons is the same in both directions of revolution, it is convenient to utilise the same camshaft both for forward and backward running, and it is well known that this can be effected by driving the camshaft through a three-bevel drive which is provided with a jaw clutch so that the direction of drive between the camshaft and the crankshaft may be reversed, the camshaft always revolving in the same direction. This invention applies to multi-cylinder engines in which there are two lengths

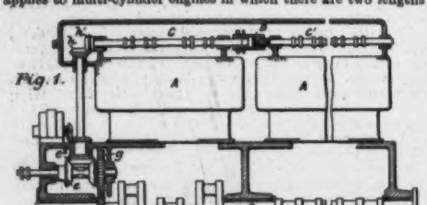


Fig. 1.

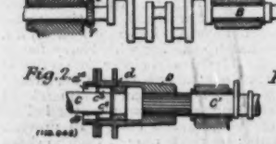
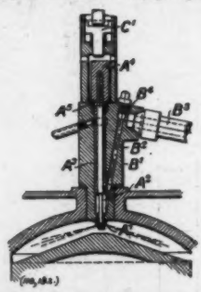


Fig. 2.

Fig. 3.

of crankshaft, each of which if used alone with its corresponding cylinders and pistons, could be reversed through the medium of a three-bevel drive, but which if taken together could not be so reversed, if used in connection with a camshaft on which the cams were unalterably fixed and which was common to all the cylinders; and consists of a modification of the invention described in Patent Specification No. 14480 of 1916, according to which there is used, in respect of each length of crankshaft, a camshaft in respect of the valves for each corresponding group of cylinders, and the camshafts are both driven through a single reversing mechanism, and connected with one another through the medium of a clutch which can be moved to couple two shafts together in two different angular relations to one another, namely, in the relation to one another required for the forward running of the engine, and in the relation to one another required for the reverse running of the engine. A, A are groups of cylinders, B is the crankshaft. The camshafting for operating the valves is formed in two lengths C, C^1, which may be coupled together by a clutch D, and may then be readily uncoupled by moving the clutch endwise into its mid position shown clearly by Fig. 2. These lengths of shaft are both driven from the crankshaft through the medium of the spur wheels *f* and *g*, three-bevel drive *e*, e^1, e_2, and bevel wheels *h*, h^1. The clutch D is slidable upon a splined end of the shaft C^1, and cannottherefore turn in relation to such shaft. The end of the shaft C is formed with teeth c^2, c^3, which differ substantially in size or shape, and when the clutch is in its mid position, as shown by Fig. 2, are within a chamber *d* of the clutch which constitutes a neutral space, and the shafts C, C^1 are then unclutched from one another. Within walls of the clutch, which are at opposite sides of the chamber *d*, are formed gaps or notches d^2, d^3, of which the gaps d^2 correspond in size to the tooth c^2, and the gaps d^3 correspond in size to the tooth c^3. In reversing the engine, the endwise movable member of the clutch mechanism of the three-bevel drive is operated to reverse such drive, and the clutch D is moved to its mid position, thereby uncoupling the camshaft C^1 from the camshaft C. As the camshaft C is then turned by the crankshaft, the clutch D is pressed still further in the direction in which it has been moved to uncouple the shaft C^1 from the shaft C, and immediately the gaps d^2, d^3, of the wall of the clutch which is then pressing against the ends of the teeth c^2, c^3, of the shaft C come into register with such teeth, respectively, the gaps slide over the teeth and couple the shaft C^1 again to the shaft C. Each gap in one wall of the clutch is, however, as indicated by broken lines, Fig. 3, in such angular relation to the corresponding gap in the other wall of the clutch as to ensure that when the gaps in one wall of the clutch have been disengaged from the teeth of the shaft C, and the gaps of the other wall have been engaged with such teeth, the shafts C and C^1 will be in their relative positions for running the engine in the reverse direction. In the particular arrangement illustrated, each gap of one wall of the clutch D is at an angle of 45 deg. with the corresponding gap of the other wall. (*Accepted October* 17, 1917.)

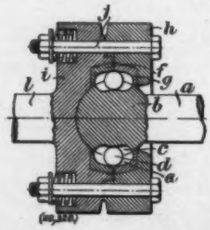
110,182. F. W. Lanchester, London. Valves and Valve Operating Mechanism. (3 *Figs.*) October 9, 1916.—The invention relates to fuel-feed valves for internal-combustion engines, and refers more especially to an improved type of valve and valve-operating mechanism for internal combustion engines of the high-pressure self-ignition type. The invention relates to fuel valves and fuel-valve gears of the type in which the valve is opened by impact, and consists in opening the fuel valve by the direct impact of a suitably-timed hammer or "tup," which strikes the valve stem or piece rigidly fastened thereto. A^1 is the valve head, of which the stem A^2 is securely attached to the balance plunger A^3. This plunger has formed on it a butt A^4 adapted to be acted upon by impact in the manner hereinafter described: B^1 is the valve-box having a passage B^2 for the



supply of liquid fuel, admitted under pressure through a supply pipe B^3 and port B^4; A spring A^5 retains valve A^1, seated independently of the pressure-force difference. The valve unit is actuated by the impact of a hammer or tup C^1 striking the valve butt A^4, the said impact causing the valve to lift against the pressure on the differential area and the valve spring. The blow thus administered causes the valve to jump, the period during which it thus remains open being very brief, but nevertheless sufficient to permit of the injection of the fuel under the heavy pressure which is employed in order to spray or atomise the charge. The hammer C^1 is fitted within the cylinder D^1 and is raised into its topmost position by a spring. Air pressure is admitted at a prearranged point of the cycle, an appropriate degree in advance of the required fuel injection, and acts on the tup C^1 to overcome the spring pressure and give the required blow. (*Accepted October* 24, 1917.)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

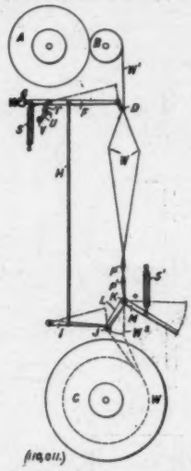
110,320. S. Hawkins and S. C. Hawkins, Highgate. Universal Joints. (2 *Figs.*) June 9, 1917.—This invention relates to ball-and-socket joints of the type in which a number of balls engage longitudinal grooves formed on a ball on the end of one shaft, and inside a spherical shell on the other shaft. It consists in combining such a joint with means for allowing one shaft of the joint to revolve, free of the other shaft when desired. The shaft *a* is formed with a spherical end *b*, which is provided externally with a number of radial recesses *c*. These recesses partly house a number of balls *d*. The other part-housing of



the balls is provided by internal radial recesses *e* in two slip rings *f* and *g* which register together, so constructed for assembling The other shaft 1 is provided with two diaphragms h and *i*, which are registered together and secured by a number of bolts *j* with springs below the nuts, thereby allowing them to be spread apart by any suitable method. The two slip rings on their outside diameter are formed on the clutch principle and are accommodated in the shell of the shaft 1. By this, when the diaphragms of shaft 1 are held close together, a grip is formed on the slip rings, and power is thereupon transmitted through the medium of the balls to shaft *a*. When the diaphragms of shaft 1 are spread apart it allows the slip rings to revolve freely on, and in part, with shaft *a*. (*Accepted October* 24, 1917.)

TEXTILE MACHINERY.

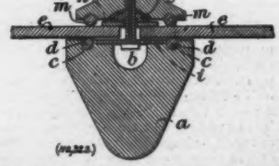
110,011. The Pneumatic Loom Syndicate, Limited, Birmingham, and M. T. Pickstone, Prestwich, Manchester. Shuttle Stop Motions. (2 *Figs.*) October 4, 1916.—This invention relates to stop motions for weaving looms. A is a cloth roller, B a taking-up roller, and C is a warp beam from which a warp W passes and is woven into cloth W^1; D indicates one of the two temples, each of which is carried on the outer end of the lever F. To the rear end of the lever F a spring S is attached. The spring S if permitted, would draw the lever F into the position indicated by dotted lines; normally, however, the lever F is held in a horizontal position by a spring-controlled catch G, the spring S being put under tension. The power of the spring-controlled catch G is slightly in excess of the spring S when the temple is in its operative position and the rod is horizontal. To the lever F, a connecting link H is secured, and is attached at its lower end to a catch lever I. The forward end of the catch lever I is hook-shaped, and engages a shaft J, extending across the loom and carried by arms L. M is a hand lever. A spring S_1 is attached to M, and when the lever M is in its depressed and normal position—indicated by full lines—the spring S_1 is under tension. When the parts are in operative weaving position, in passing from the warp beam C, the warp



threads are deflected at W out of their shortest path from the beam to the fell of the cloth (at D) and the taking-up roller B, as indicated by a solid line. The warp threads pass round J, which is held in its rear position, and then travels in an outward direction to the rod or shaft K, and then vertically to the lease rods P_1, P. Should the shuttle remain in the shuttle-race or between the divided warp threads as the slay beats up, the pressure exerted against the fell of the cloth or one of the temples is sufficient to overcome the pressure of the spring-controlled catch G. Immediate y this pressure is overcome the spring S acts to draw the rear end of the temple lever F downwards and tilt the forward end into the position indicated in dotted lines. At the same time the finger T depressed the finger U, causing the shaft V to partially rotate, and in doing so to actuate any suitable mechanism to bring the loom to rest. Simultaneously with the operations described the link H is raised, and raises the catch lever I and releases the shaft J, so that the lever M can be raised by the spring S_1 up against a stop, the arms L and rod J at the same time moving in a counter clockwise direction and releasing the extra length of the warp threads, which assume the path indicated in broken lines at W^2, thus relieving the pressure due to the failure of the shuttle to enter the box. (*Accepted October* 17, 1917.)

MISCELLANEOUS.

110,323. G. E. Merredew, Hendon. Roof Glazing. (1 *Fig.*) June 12, 1917.—This invention relates to roof glazing and consists of an improved construction, according to which the sheets of glass are secured and retained in position on the glazing bars independently of the joint-capping piece which holds in place the weather-resisting packing on the outer faces of the glass sheets, so that if the capping pieces be removed the sheets will still remain secured to the bars. *a* is the glazing bar, provided on its upper surface with a central groove *b* for the passage of condensation water, and, preferably, also with two seatings *c* for the reception of asbestos cords *d* in which the sheets of glass *e* are bedded. The sheets of glass *e* are secured in place by means of bolts, nuts and washers in the following manner: One or more bolts *f* are used between each pair of glass



sheets. The heads of the bolts are arranged in the channel *b*, and with their underside are made to bear against plates *i* which are fixed to the upper surface of the bar *a*. The shanks of the bolts pass each through a plate *i*, and the space between the adjacent side edges of two rows of glass sheets. It is obvious that if the sheets *e* be placed on the asbestos cords *d*, and the nut *g* be screwed along the bolt *f* until the packing *d* is sufficiently compressed, and the washer *h* is tight against the sheets *e*, the latter will become firmly held or secured to the bar *a*. To keep out the weather, the nut *g* and washer *h* can be protected by a longitudinally-disposed capping-piece *j*, retained in position by making the shanks of the bolts *f* sufficiently long. Asbestos cords *m* are preferably interposed between the capping *j* and the sheets *e*. (*Accepted October* 24, 1917.)